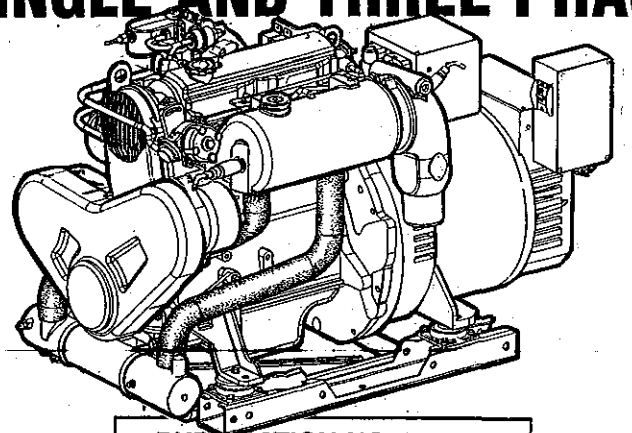
# OPERATORS MANUAL

## 20.0 KW SBEG and SBEGA - 60 HZ
## 16.0 KW SBEG and SBEGA - 50 HZ

## 22.5 KW SBEG and SBEGA - 60 HZ
## 18.7 KW SBEG and SBEGA - 50 HZ

# MARINE GASOLINE GENERATORS

## SINGLE AND THREE PHASE



PUBLICATION NO. 049800
FOURTH EDITION
MAY 2009

*Ultra-Low Carbon Monoxide Emissions*

WESTERBEKE™ GENERATORS

SAFE CO™

## ⚠ WARNING

***Exhaust gasses contain Carbon Monoxide, an odorless and colorless gas. Carbon Monoxide is poisonous and can cause unconsciousness and death. Symptoms of Carbon Monoxide exposure can include:***

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

***IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not restart until it has been inspected and repaired.***

***A WARNING DECAL is provided by WESTERBEKE and should be fixed to a bulkhead near your engine or generator.***

***WESTERBEKE also recommends installing CARBON MONOXIDE DETECTORS in the living/sleeping quarters of your vessel. They are inexpensive and easily obtainable at your local marine store.***

## CALIFORNIA PROPOSITION 65 WARNING

**Marine diesel and gasoline engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.**

# SAFETY INSTRUCTIONS

## INTRODUCTION

*Read this safety manual carefully. Most accidents are caused by failure to follow fundamental rules and precautions. Know when dangerous conditions exist and take the necessary precautions to protect yourself, your personnel, and your machinery.*
*The following safety instructions are in compliance with the American Boat and Yacht Council (ABYC) standards.*

## PREVENT ELECTRIC SHOCK

**⚠ WARNING:** ***Do not touch AC electrical connections while engine is running. Lethal voltage is present at these connections!***

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.
- Electrical shock results from handling a charged capacitor. Discharge capacitor by shorting terminals together.

## PREVENT BURNS — HOT ENGINE

**⚠ WARNING:** ***Do not touch hot engine parts or exhaust system components. A running engine gets very hot!***

- Always check the engine coolant level at the coolant recovery tank.

**⚠ WARNING:** ***Steam can cause injury or death!***

- In case of an engine overheat, allow the engine to cool before touching the engine or checking the coolant.

## PREVENT BURNS — FIRE

**⚠ WARNING:** ***Fire can cause injury or death!***

- Prevent flash fires. Do not smoke or permit flames or sparks to occur near the carburetor, fuel line, filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. Use a suitable container to catch all fuel when removing the fuel line, carburetor, or fuel filters.
- Do not operate with the air cleaner/silencer removed. Backfire can cause severe injury or death.
- Do not smoke or permit flames or sparks to occur near the fuel system. Keep the compartment and the engine/generator clean and free of debris to minimize the chances of fire. Wipe up all spilled fuel and engine oil.
- Be aware — Diesel fuel will burn.

## PREVENT BURNS — EXPLOSION

**⚠ WARNING:** ***Explosions from fuel vapors can cause injury or death!***

- All fuel vapors are highly explosive. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children.
- Do not fill the fuel tank(s) while the engine is running.
- Shut off the fuel service valve at the engine when servicing the fuel system. Take care in catching any fuel that might spill. DO NOT allow any smoking, open flames, or other sources of fire near the fuel system or engine when servicing. Ensure proper ventilation exists when servicing the fuel system.
- Do not alter or modify the fuel system.
- Be sure all fuel supplies have a positive shutoff valve.
- Be certain fuel line fittings are adequately tightened and free of leaks.
- Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

## ACCIDENTAL STARTING

**⚠ WARNING:** ***Accidental starting can cause injury or death!***

- To prevent accidental starting when servicing the generator, remove the 8 amp fuse from the control panel.
- Disconnect the battery cables before servicing the engine/generator. Remove the negative lead first and reconnect it last.
- Make certain all personnel are clear of the engine before starting.
- Make certain all covers, guards, and hatches are re-installed before starting the engine.

# SAFETY INSTRUCTIONS

## BATTERY EXPLOSION

**⚠ WARNING:** ***Battery explosion can cause injury or death!***

- Do not smoke or allow an open flame near the battery being serviced. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or by lit tobacco products. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.
- Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while the battery is being charged.
- Avoid contacting the terminals with tools, etc., to prevent burns or sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling the battery.
- Always turn the battery charger off before disconnecting the battery connections. Remove the negative lead first and reconnect it last when disconnecting the battery.

## BATTERY ACID

**⚠ WARNING:** ***Sulfuric acid in batteries can cause severe injury or death!***

- When servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Batteries contain sulfuric acid which is destructive. If it comes in contact with your skin, wash it off at once with water. Acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

**⚠ WARNING:** ***Carbon monoxide (CO) is a deadly gas!***

- Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check the exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists. Pay close attention to the manifold, water injection elbow, and exhaust pipe nipple.
- Be sure the unit and its surroundings are well ventilated.
- In addition to routine inspection of the exhaust system, install a **carbon monoxide detector**. Consult your boat builder or dealer for installation of approved detectors.

**⚠ WARNING:** ***Carbon monoxide (CO) is an invisible odorless gas. Inhalation produces flu-like symptoms, nausea or death!***

- Do not use copper tubing in diesel exhaust systems. Diesel fumes can rapidly destroy copper tubing in exhaust systems. Exhaust sulfur causes rapid deterioration of copper tubing resulting in exhaust/water leakage.
- Do not install exhaust outlet where exhaust can be drawn through portholes, vents, or air conditioners.
- Although diesel engine exhaust gases are not as toxic as exhaust fumes from gasoline engines, carbon monoxide gas is present in diesel exhaust fumes. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are:

| | |
|---|---|
| Vomiting | Muscular twitching |
| Dizziness | Intense headache |
| Throbbing in temples | Weakness and sleepiness |

## AVOID MOVING PARTS

**⚠ WARNING:** ***Rotating parts can cause injury or death!***

- Do not service the engine while it is running. If a situation arises in which it is absolutely necessary to make operating adjustments, use extreme care to avoid touching moving parts and hot exhaust system components.
- Do not wear loose clothing or jewelry when servicing equipment; tie back long hair and avoid wearing loose jackets, shirts, sleeves, rings, necklaces or bracelets that could be caught in moving parts.
- Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective places at all times.
- Do not check fluid levels or the drive belt's tension while the engine is operating.

## HAZARDOUS NOISE

**⚠ WARNING:** ***High noise levels can cause hearing loss!***

- Never operate an engine without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.
- Do not run engines for long periods with their enclosures open.

**⚠ WARNING:** ***Do not work on machinery when you are mentally or physically incapacitated by fatigue!***

# SAFETY INSTRUCTIONS

## OPERATORS MANUAL

Many of the preceding safety tips and warnings are repeated in your Operators Manual along with other cautions and notes to highlight critical information. Read your manual carefully, maintain your equipment, and follow all safety procedures.

## GASOLINE ENGINE AND GENERATOR INSTALLATIONS

Preparations to install a gasoline engine or generator should begin with a thorough examination of the American Boat and Yacht Council's (ABYC) standards. These standards are from a combination of sources including the USCG and the NFPA.

Sections of the ABYC standards of particular interest are:

H-2 Ventilation
H-24 Gasoline Fuel Systems
P-1 Exhaust Systems
P-4 Inboard Engines
E-9 DC Electrical Systems

All installations must comply with the Federal Code of Regulations (FCR).

## ABYC, NFPA AND USCG PUBLICATIONS FOR INSTALLING DIESEL ENGINES

Read the following ABYC, NFPA and USCG publications for safety codes and standards. Follow their recommendations when installing your engine.

**ABYC** (American Boat and Yacht Council)
"Safety Standards for Small Craft"

Order from:

ABYC
3069 Solomon's Island Rd.
Edgewater, MD 21037

**NFPA** (National Fire Protection Association)
"Fire Protection Standard for Motor Craft"

Order from:

NFPA
11 Tracy Drive
Avon Industrial Park
Avon, MA 02322

**USCG** (United States Coast Guard)
"USCG 33CFR183"

Order from:

U.S. Government Printing Office
Washington, D.C. 20404

# CARBON MONOXIDE "CO"/SAFE-CO GENERATORS
## IMPORTANT INFORMATION

### DESCRIPTION

Carbon monoxide "CO" is a component of engine exhaust. It is a colorless, tasteless, odorless, lighter than air poisonous gas that can kill you without any warning. CO poisoning is one of the major safety risks associated with boating. It is a threat that must not be underestimated.

Several standards for CO have been published, expressed in parts per million "ppm" and hours of exposure:

| Regulator | CO ppm | Exposure Hours |
|---|---|---|
| EPA | 9 | 8 |
| ACGIH | 25 | 8 |
| EPA | 35 | 1 |
| NIOSH | 35 | 8 |
| OSHA | 50 | 8 |
| ACGIH | 125 | 0.5 |
| NIOSH | 200 | 0.0 |
| NIOSH (IDLH) | 1200 | 0.0 |

**1200 ppm is the so-called IDLH concentration - IMMEDIATELY DANGEROUS TO LIFE AND HEALTH.**

A city in California characterizes the effect of CO concentration this way:

| Parts per Million | Responses |
|---|---|
| 25 | Permissible exposure level, no apparent toxic symptoms. |
| 100 | No poisoning for long period. Allowable for several hours. |
| 200 | Should not be exposed above this level for any period of time. A possible mild frontal headache in two to three hours. |

Even though Westerbeke Safe-CO generators are designed to reduce normal levels of CO in the engine exhaust by approximately 99%, an exhaust leak of untreated exhaust would be extremely dangerous. For this reason it is extremely important to install a CO detector near the generator and to be sure it is always turned on and functioning properly. If this detector sounds, do not turn it off, assuming it is a false signal. You can not taste, smell, or otherwise detect CO. Leave the detector on, turn off all engines and generators, evacuate the boat leaving ports and hatches open, and seek professional help.

As soon as CO leaves the exhaust outlet, the level is subject to dilution in the open air. The closer a person is to the exhaust outlet, the higher the concentration of CO.

In a closed space, such as the engine compartment, the boat, or underneath a stern swim platform, concentrations will potentially rise to the undiluted level emanating from the exhaust system due to a lack of fresh air to dilute the exhaust gas. Therefore, one should never rely on dilution of the exhaust to provide a margin of safety.

Westerbeke Safe-CO generators achieve an approximate 99% reduction of typical CO by precise control control of the engine's air/fuel ration coupled with after treatment in a special catalyst. CO emissions are not the same for every model because each engine is different. Also, certain fuel system components are commonized across several engine models being adequate for some and extra-adequate for others, thus producing different CO levels for different models.

The fuel system which accomplishes the required precise air/fuel ratio control is comprised of many different components: purchased sub-assemblies, machined castings, sensors, electronics and others. Because of the extreme level of CO reduction, any variability in the functioning of any these components can and will cause variability of the CO output.

CO concentration also varies with load. Usually, but not always, the worst case CO concentration occurs at maximum load.

### INSPECTION

The catalyst is critical to optimizing CO levels. Any water intrusion into the exhaust system will likely quickly compromise the proper operation of the catalyst. Westerbeke's exhaust system installation instructions dated on or after February 2004 must be adhered to.

**NOTE:** *Water intrusion is not a product defect and is not covered under warranty, neither Westerbeke's normal product warranty nor the emissions specific warranty mandated by various regulating authorities such as EPA and CARB.*

Maintenance of any components affecting the flow of air or the flow of fuel to the engine is critically important, such as fuel filters and air filters (if any).

Inspection of the catalyst at the prescribed intervals is critically important. The exhaust elbow is removed by loosening the metal clamp to provide a view of the output surface of the catalyst. Any visual irregularity of the normal flush, honeycomb appearance is most likely a result of water intrusion. The cause of the irregularity must be identified and addressed. If there is irregularity, the catalyst and gasket must be replaced. Upon careful reassembly of the catalyst, exhaust elbow gasket, and exhaust elbow, check for the presence of CO while the engine is running. This must be performed with a CO analyzer.

# CARBON MONOXIDE "CO"/SAFE-CO GENERATORS
## IMPORTANT INFORMATION

Catalyst performance will degrade over time. As the generator accumulates operating hours, CO concentrations will increase. **The catalyst must be replaced every 2,000 hours of engine operation.**

**Verification of satisfactory CO levels must be done seasonally or each 1,000 hours (which ever occurs first).** Verification involves actual sampling of exhaust gas with an appropriate CO analyzer.

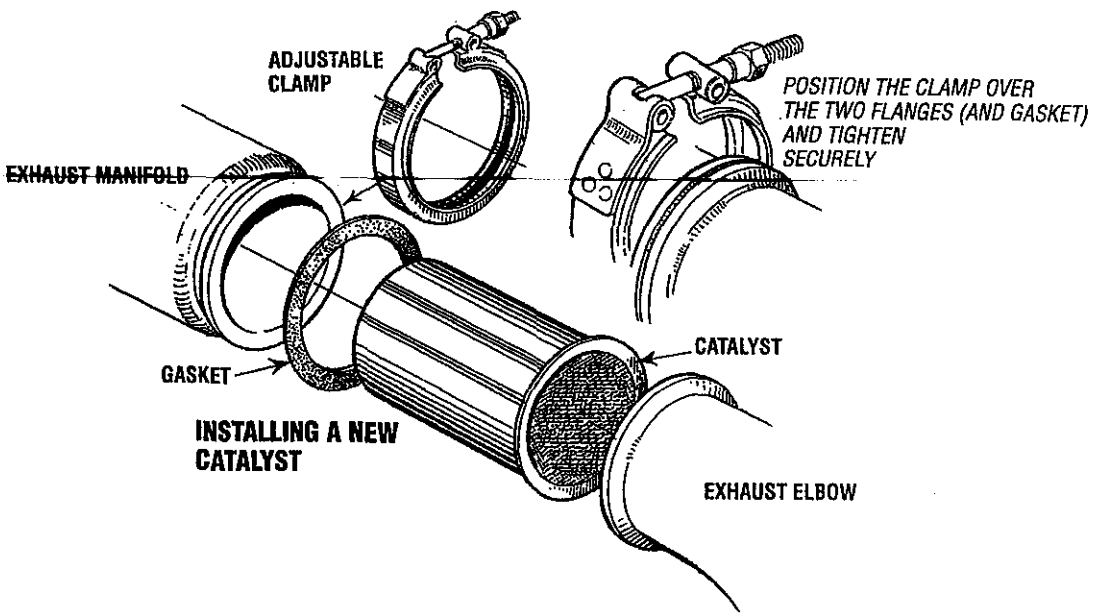
There are two locations where exhaust gas can be sampled. Dry, but hot, exhaust can be sampled at the plugged tapped hole in the exhaust elbow intended for back pressure measurements. Measurements at this location may not be practical in all instances due to the high exhaust temperature, temperature limits of the analyzer, safety concerns over temperatures involved or the possibility of high levels of CO. The other location is the boat's exhaust outlet, which contains entrained cooling water (except dry stack exhaust systems). Only analyzers with probes should be used at this location and it is critical that the probe not ingest water. Probe-type analyzers have an air pump drawing a gas sample through the probe. As a result, they tend to ingest water when it is present. Be sure to aim the probe downwards with the opening pointed in the direction of the water flow and just out of the flow. Position the analyzer as high as possible with the tubing leading to the probe running continuously downhill. Observe the usually translucent tubing between the probe and the analyzer and be sure no water is being ingested. If any water is ingested into the analyzer, it must be repaired or replaced and recalibrated.

When measuring CO at the exhaust outlet be aware of the ambient CO level by also measuring CO away from and upwind of the exhaust outlet, especially in marinas. the CO level at the exhaust will be influenced upwards by the ambient level.

Whenever taking the time to verify proper CO concentration from the exhaust with a CO analyzer, always take the opportunity to use the analyzer to "sniff" around the engine looking for CO from exhaust leaks. Pay close attention to the connection of the cylinder head to the exhaust manifold, the exhaust manifold to the water injected exhaust elbow, and all subsequent downstream exhaust components and hoses. Remember, exhaust gas that has not yet passed through the catalyst is raw, untreated exhaust and is very high in CO content.

Analyzers usually require periodic calibration. Follow the instructions that come with the analyzer very carefully regarding calibration.

The following are manufacturers that offer CO analyzers: Extech, TIF, Testo, TSI, Bacharach, Fluke, Monoxor, Fyrite, Zellwgwer Analytics, Industrial Scientific Corp, GFG, TPI, Teledyne and others. Westerbeke recommends analyzers with a probe connected to the analyzer by a length of transparent tubing. They are slightly more expensive than those with the sensor built into one end of the analyzer, but they allow you to sample the exhaust coming out of the boat's exhaust outlet.



# EMISSIONS

This genset meets the requirements of California's Exhaust Emissions Standards as stated on the nameplate.

California users of this genset should be aware that unauthorized modifications or replacement of fuel, exhaust, air intake, or speed control system components that affect engine emissions are prohibited. Unauthorized modification, removal or replacement of the engine label is prohibited.

*Federal Emissions Compliance Period:* The Federal Emissions Compliance Period referred to on the nameplate indicates the number of operating hours for which the engine has been shown to meet Federal Emissions requirements.

Catagory C= 250 hrs, B=500 hrs,m A =1000.hrs.

You should carefully review operator (Owner) Installation and other manuals and information you receive with your genset. If you are unsure that the installation, use, maintenance or service of your genset is authorized, you should seek assistance from an approved WESTERBEKE dealer.

California genset users may use the table below as an aid in locating information related to the California Air Resources Board requirements for emissions control.

**EMISSIONS CONTROL INFORMATION TABLE**

| | |
|---|---|
| **Emissions Warranty Information** | The California emissions control warranty statement is located in the same packet, if information as this manual when the genset is shipped from the factory. |
| **Engine Fuel Requirements** | The engine is certified to operate on unleaded gasoline. See *FUEL RECOMMENDATIONS.* |
| **Engine Valve Adjustment** | See *MAINTENANCE SCHEDULE.* |
| **Engine Ignition Timing** | See *MAINTENANCE SCHEDULE.* |
| **Engine Lubricating Oil Requirements** | See *ENGINE OIL RECOMMENDATIONS.* |
| **Engine Adjustments** | ECU. |
| **Engine Emission Contol System** | The engine emission control system consists of engine design and precision manufacture. |
| **Catalyst** | See *MAINTENANCE SCHEDULE.* |
| **Oxygen Sensor** | See *MAINTENANCE SCHEDULE.* |
| **Back Pressure** | See *MAINTENANCE SCHEDULE.* |

## EMISSION-RELATED INSTALLATION INSTRUCTIONS

**"Failing to follow these instructions when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act."**

If your product is equipped with OBD (on board diagnostics) go to www.WESTERBEKE.COM and follow the free interface software download instructions specific to your engine to obtain and install the appropriate diagnostic software. The following is a list of OBD compliant products:

20.0 SBEGA
22.5 SBEGA

To sample exhaust emissions on installed OBD compliant generators, gain access to the exhaust stream by removing the test port plug on the exhaust elbow. Be sure to reinstall the plug securely when testing is complete.

**The Westerbeke generator that you purchased is certified for constant-speed operation only. The use of any Westerbeke product in any manner inconsistent with its intended use could be a violation of Federal Law.**

**"If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105". Contact the factory for an additional engine emission control information label if needed to comply with this rule.**

**To comply with 40 CFR 1048.105 (a) "*Fuel line permeation.* For nonmetallic fuel lines, you must specify and use products that meet the Category 1 specifications for permeation in SAE J2260 (incorporated by reference in §1048.810)."**

**To comply with 40 CFR 1048.105 (c) "*Diurnal emissions.* Evaporative hydrocarbon emissions may not exceed 0.2 grams per gallon of fuel tank capacity when measured using the test procedures specified in §1048.501. Diurnal emission controls must continue to function during engine operation."**

**To comply with 40 CFR 1048.105 (d) "*Running loss.* Liquid fuel in the fuel tank may not reach boiling during continuous engine operation in the final installation at an ambient temperature of 30 °C. Note that gasoline with a Reid vapor pressure of 62 kPa (9 psi) begins to boil at about 53 °C at atmospheric pressure, and at about 60 °C for fuel tanks that hold pressure as described in §1048.245(e)(1)(i)".**

**To comply with 40 CFR 1048.245 (1) (i) "Use a tethered or self-closing gas cap on a fuel tank that stays sealed up to a positive pressure of 24.5 kPa (3.5 psi); however, they may contain air inlets that open when there is a vacuum pressure inside the tank. Nonmetal fuel tanks must also use one of the qualifying designs for controlling permeation emissions specified in 40 CFR 1060.240."**

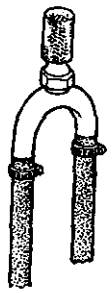
# INSTALLATION

When installing WESTERBEKE engines and generators it is important that strict attention be paid to the following information:

## CODES AND REGULATIONS

Strict federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

## SIPHON-BREAK



AVAILABLE FROM YOUR WESTERBEKE DEALER

For installations where the exhaust manifold/water injected exhaust elbow is close to or will be below the vessel's waterline, provisions must be made to install a siphon-break in the raw water supply hose to the exhaust elbow. This hose must be looped a minimum of 20" above the vessel's waterline. ***Failure to use a siphon-break when the exhaust manifold injection port is at or below the load waterline will result in raw water damage to the engine and possible flooding of the boat.***

If you have any doubt about the position of the water-injected exhaust elbow relative to the vessel's waterline under the vessel's various operating conditions, ***install a siphon-break.***

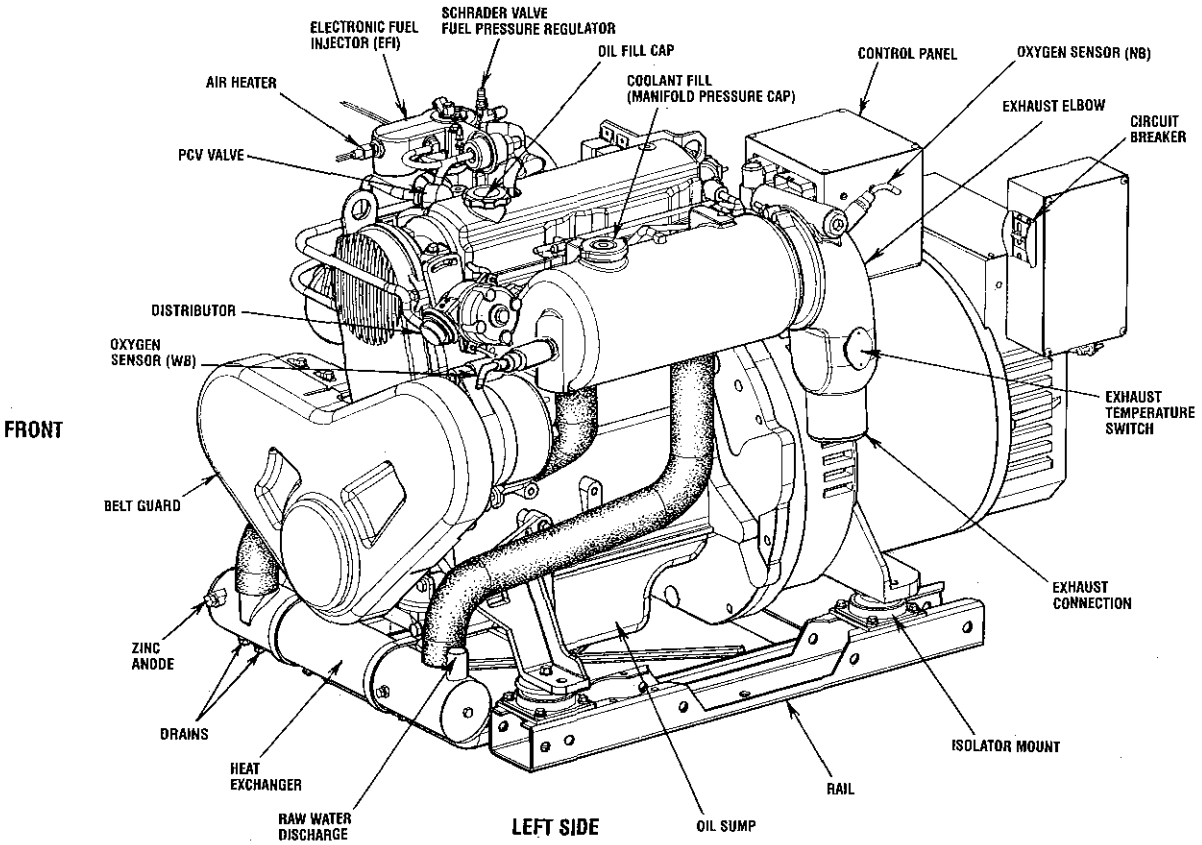
## EXHAUST SYSTEM

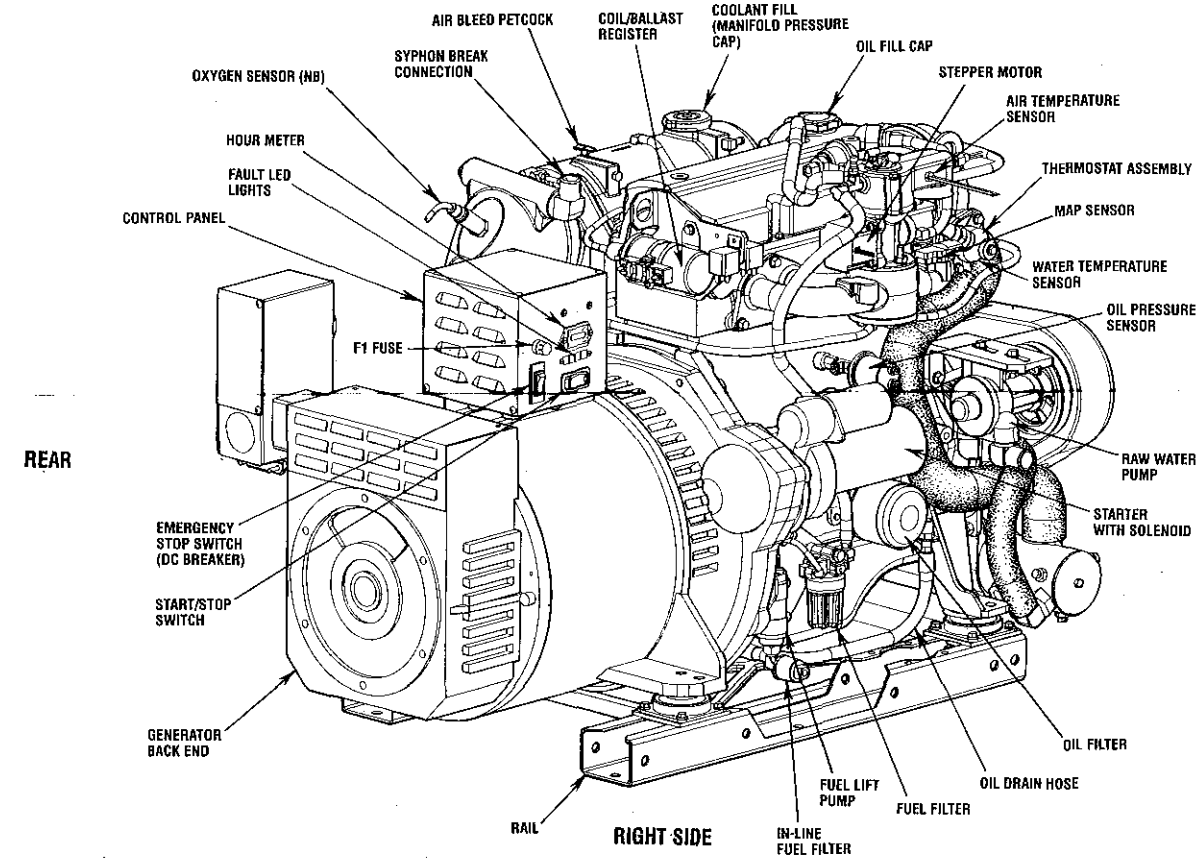
The exhaust hose must be certified for marine use. The system must be designed to prevent water from entering the exhaust under any sea conditions and at any angle of the vessels hull.

# TABLE OF CONTENTS


**20KW SBEG/22.5KW SBEG Parts Identification** .....2
**Introduction** .....3,4
**Fuel, Engine Oil and Engine Coolant** .....5
**Preparations for Initial Start-Up** .....6
**Operating Instructions** .....7
Generator Control Panel .....7
Remote Control Start/Stop Panel .....7
**Break-In Procedure/Daily Operation** .....8
**Safety Shutdown Sensors/Switches** .....9
**Maintenance Schedule** .....10,11
**Cooling System** .....12
Changing Coolant .....12
Thermostat .....13
Zinc Anode .....13
Heat Exchanger .....13
Raw Water Intake Strainer .....14
Raw Water Pump .....14
**Fuel System** .....15
Gasoline/Water Separator and Filter .....15
Engine Fuel Filter .....15
Bleeding the Fuel System .....15A
Electronic Fuel Injection (EFI) .....16
**Engine Lubrication Oil** .....17
Changing the Engine Oil .....17
Replacing the Oil Filter .....17
**Oil Pressure** .....18
Testing Oil pressure .....18
**Remote Oil filter (Optional)** .....19
**Timing Belt Inspection/Installation** .....20,21
**Engine Adjustments** .....22
Spark Plugs .....22
Drive Belt Adjustment .....22
Engine Compression Test .....23
Valve Clearance Adjustment .....24
Ignition timing .....24
Torquing the Cylinder Head Bolts .....24
**Generator Information** .....25
**The SBEG Generator (Single and Three Phase)** .....26
**Internal Wiring Schematics (Single and Three Phase)** .....27
**Generator AC Voltage Connections** .....28, 29 30
**SBEG Troubleshooting** .....31
**Generator Voltage Regulator Adjustments (Three Phase)** .....32
**Shore Power Transfer Switch** .....33
**20KW SBEG and 22.5KW SBEG Generator Wiring Diagram #49232** .....34
**Remote Control Panel Wiring Diagram #49209** .....35
**Engine Troubleshooting** .....36,37,38,39
**Lay-Up and Recommissioning** .....40,41
**20KW SBEG and 22.5KW SBEG Generator Specifications** .....42,43
**Torque Specifications** .....44
**Standard and Metric Conversion Data** .....45
**Metric Conversions** .....46
**Suggested Spare Parts** .....47

# 20KW SBEG/22.5KW SBEG PARTS IDENTIFICATION



# INTRODUCTION

This WESTERBEKE Generator is a product of WESTERBEKE's long years of experience and advanced technology. We take great pride in the superior durability and dependable performance of our engines and generators. Thank you for selecting WESTERBEKE.

In order to get the full use and benefit from your generator, it is important that you operate and maintain it correctly. This manual is designed to help you do this. Please read this manual carefully and observe all the safety precautions throughout. Should your generator require servicing, contact your nearest WESTERBEKE dealer for assistance.

This is your operators manual. Along with this manual there is an Installation manual and a unit parts print. A Service manual is available and can be ordered from your local WESTERBEKE/UNIVERSAL dealer.

## WARRANTY PROCEDURES

Your WESTERBEKE Warranty is included in a separate folder. If you have not received a customer identification card registering your warranty 60 days after submitting the warranty registry form, please contact the factory in writing with model information, including the unit's serial number and commission date.

WESTERBEKE
Engines & Generators

**Customer Identification**
WESTERBEKE OWNER
MAIN STREET
HOMETOWN, USA
Model Ser. #
Expires

## CUSTOMER IDENTIFICATION CARD (TYPICAL)

The WESTERBEKE serial number is an alphanumeric number that can assist in determining the date of manufacture of your WESTERBEKE engine/generator. The first character indicates the decade (A=1960's, B=1970', C=1980's, D=1990's, E=2000's), the second character represents the year in the decade, and the fourth and fifth numbers represent the month of manufacturer.

## PRODUCT SOFTWARE

Product software, (tech data, parts lists, manuals, brochures and catalogs), provided from sources other than WESTERBEKE are not within WESTERBEKE'S CONTROL.

***WESTERBEKE CANNOT BE RESPONSIBLE FOR THE CONTENT OF SUCH SOFTWARE, MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT THERETO, INCLUDING ACCURACY, TIMELINESS OR COMPLETENESS THEREOF AND WILL IN NO EVENT BE LIABLE FOR ANY TYPE OF DAMAGE OR INJURY INCURRED IN CONNECTION WITH OR ARISING OUT OF THE FURNISHING OR USE OF SUCH SOFTWARE.***

WESTERBEKE customers should also keep in mind the time span between printings of WESTERBEKE product software and the unavoidable existence of earlier WESTERBEKE manuals. In summation, product software provided with WESTERBEKE products, whether from WESTERBEKE or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense but is imperative that appropriate representatives of WESTERBEKE or the supplier in question be consulted to determine the accuracy and currentness of the product software being consulted by the customer.

## SERIAL NUMBER LOCATION

The engine and generator serial numbers and model numbers are located on a decal on the generator housing. Take the time to enter the information on the blank decal provided below as this will provide a quick reference when seeking technical information and/or ordering repair parts.

| SPECIFICATION | 50 HZ. | 60 HZ. |
|---|---|---|
| MODEL | | |
| RPM | | |
| KW | | |
| KVA | | |
| VOLTS | | |
| AMPS | | |
| ENG. HP | | |
| ENG. SER. NO. | | |
| GEN. SER. NO. | | |
| PF/PHASE | / | |
| WIRES | | |
| RATING | | |
| INSUL. CLASS | | |
| TEMP. RISE | | |
| BATTERY | | |
| C.I.D. | | |

*Fill in the information for your own reference.*

# INTRODUCTION

The *engine/generator* model number and serial number are located on a plate mounted on the engine's valve cover.

## UNDERSTANDING THE GASOLINE ENGINE

The gasoline engine driving an AC generator is in many ways similar to a gasoline automobile engine. The cylinders are verticle in-line, and the engine's cylinder head has an over-head camshaft which is chain-driven. The engine utilizes a solid-state distributor which is horizontally mounted and camshaft-driven. The engine incorporates a pressure type lubrication system, and a fresh water-cooled engine block which is thermostatically controlled. To a large degree, the generator's engine requires the same preventative maintenance that is required of a gasoline automobile engine. the most important factors to the generator's longevity are proper ventilation, maintenance of the fuel system, ignition system, cooling system and the generator back-end.

## ORDERING PARTS

Whenever replacement parts are needed, always provide the generator and engine model and serial numbers. In addition, include a complete part description and part number for each part needed . Also insist upon WESTERBEKE packaged parts because *will fit* or generic parts are frequently not made to the same specifications as original equipment.

## NOTES, CAUTIONS AND WARNINGS

As this manual takes you through the operating procedures, maintenance schedules, and troubleshooting of your generator,, critical information will be highlighted by NOTES, CAUTIONS, and WARNINGS. An explanation follows:

**NOTE:** *An operating procedure essential to note.*

**⚠ CAUTION:** ***Procedures, which if not strictly observed, can result in the damage or destruction of your engine.***

**⚠ WARNING:** ***Procedures, which if not properly followed, can result in personal injury or loss of life.***

## PROTECTING YOUR INVESTMENT

Care at the factory during assembly and thorough testing have resulted in a WESTERBEKE generator capable of many thousands of hours of dependable service. However the manufacturer cannot control how or where the generator is installed in the vessel or the manner in which the unit is operated and serviced in the field. this is up to the buyer/owner operator.

**NOTE:** *Six important steps to ensure long generator life:*

- ***Proper engine and generator installation.***
- ***An efficient well-designed exhaust system that includes an anti-siphon break to prevent water from entering the engine.***
- ***Changing the engine oil and oil filters every 100 operating hours.***
- ***Proper maintenance of all engine and generator components according to the maintenance schedule in this manual.***
- ***Use clean, filtered unleaded fuel.***
- ***Winterize your engine according to the LAY-UP AND RECOMMISSIONING section in this manual.***

## SPARES AND ACCESSORIES

Certain spares will be needed to support and maintain your WESTERBEKE generator or engine when cruising (see *SUGGESTED SPARE PARTS*). Often even simple items such as proper fuel and oil filters can be difficult to obtain along the way. WESTERBEKE will provide you with a suggested spares and accessories brochure to assist you in preparing an on-board inventory of the proper WESTERBEKE parts.

# FUEL, ENGINE OIL AND ENGINE COOLANT

## GASOLINE

> ⚠ **CAUTION:** ***Only use unleaded fuel with an octane rating of 89 or higher. Leaded fuel will cause serious harm to your engine and violate your warranty.***

### Care Of The Fuel Supply

Use only clean, well filtered gasoline. The passages in the carburetors and the clearances in the fuel injection equipment are very critical for proper fuel flow. Small contaminants not captured in the primary filter/water seperator can clog these passages and affect these clearances, It is important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by careless handling or improper storage facilities. To assure that the fuel going into the tank for your engine's daily use is clean and pure, the following practice is advisable:

Purchase a well-known brand of fuel.

Install and regularly service a good, Coast Guard approved metal bowl type filter/water separator between the fuel tank and the engine.

## ENGINE OIL

Use a heavy duty engine oil with an API classification of SJ. Change the engine oil and filter after an initial 50 hours of break-in operation, and every 100 hours of operation thereafter. An oil viscosity of SAE 15W-40 is recommended for this engine in all conditions.

## ENGINE COOLANT

WESTERBEKE recommends a mixture of 50% antifreeze and 50% distilled water. Distilled water is free from the chemicals that can corrode internal engine surfaces.

The antifreeze performs double duty. It allows the engine to run at proper temperatures by transferring heat away from the engine to the coolant. It also lubricates and protects the cooling circuit from rust and corrosion. Use a good quality antifreeze that contains supplemental cooling additives (SCAs') that keep the antifreeze chemically balanced, crucial to long term protection.

The water and antifreeze should be premixed before being poured into the cooling circuit.

**NOTE:** *Use the new environmentally-friendly, long lasting, antifreeze that is now available.*

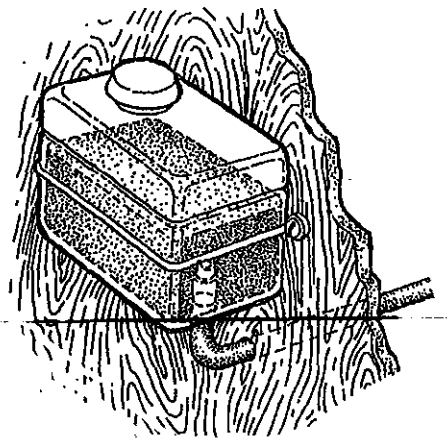
A proper 50/50 mixture as recommended will protect the engine coolant to temperatures of -40°F.

**ANTIFREEZE PROTECTION CHART**

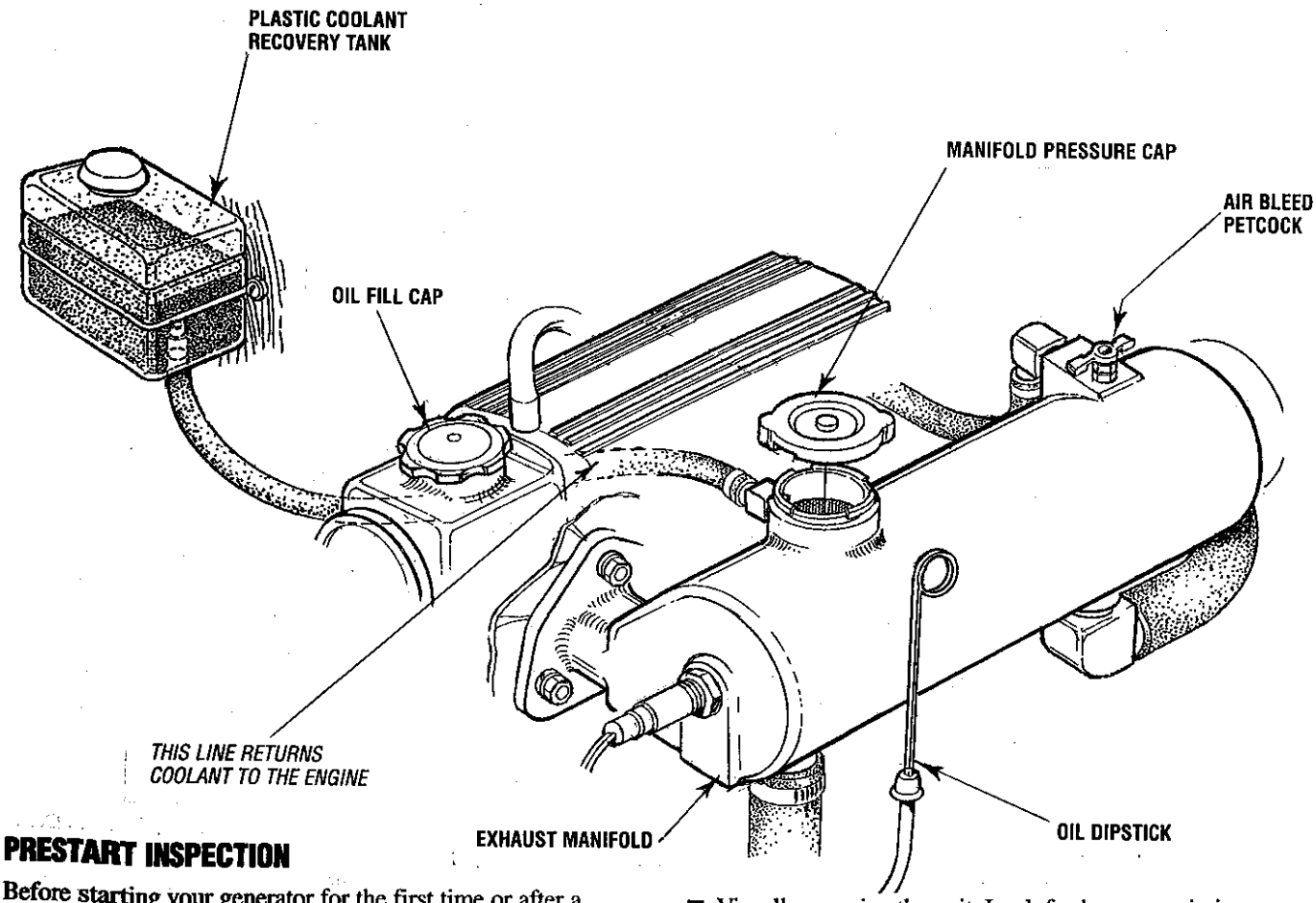
| Antifreeze concentration | 23% | 30% | 35% | 50% |
|---|---|---|---|---|
| Freezing Temperature | 14° F | 8° F | -4° F | -40° F |
| | (-10°C) | (-13°C) | (-20°C) | (-40°C) |

## COOLANT RECOVERY TANK

A coolant recovery tank kit is supplied with each generator. The purpose of this recovery tank is to allow for engine coolant expansion and contraction during engine operation, without the loss of coolant and without introducing air into the cooling system.



# PREPARATIONS FOR INITIAL START-UP




## PRESTART INSPECTION

Before starting your generator for the first time or after a prolonged layoff, check the following items:

- Check the engine oil level: add oil to maintain the level at the full mark on the dipstick.
- Check the fuel supply and examine the fuel filter/separator bowls for contaminants.
- Check the DC electrical system. Inspect wire connections and battery cable connections.

  **NOTE:** *The starting battery must be totally dedicated to the generator and maintained by the generator's DC charging alternator and no other source.*

- Check the coolant level in both the plastic recovery tank and at the manifold.

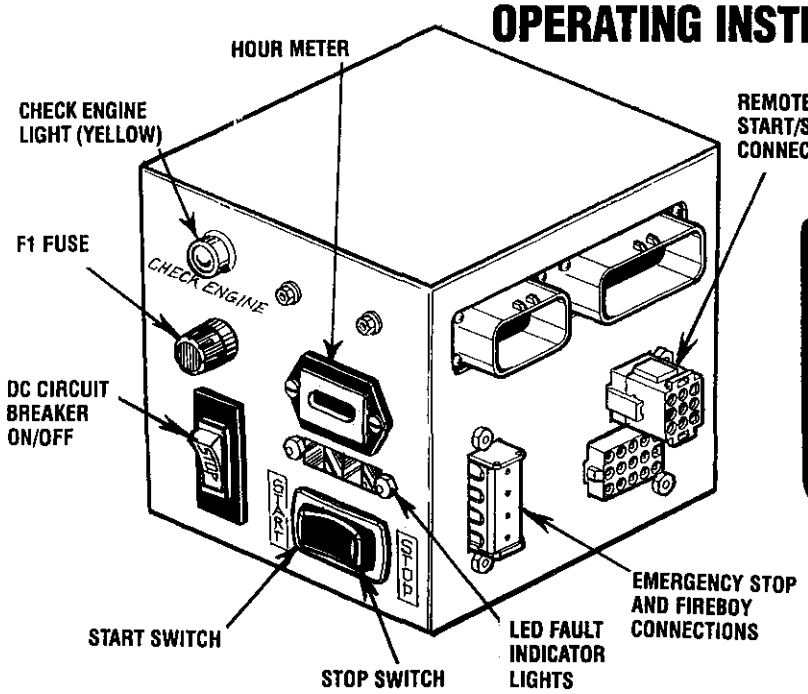
  **NOTE:** *After the initial running of the generator, the air in the engine's cooling system will be purged to the coolant recovery tank. Open the air bleed petcock to ensure that the cooling system is purged of air. After shutdown and after the engine has cooled, the coolant from the recovery tank will be drawn into the engine's cooling system to replace the purged air.*

  *Before subsequent operation of the generator, the engine's manifold should be topped off and the coolant recovery tank's level brought to 1/4 full.*

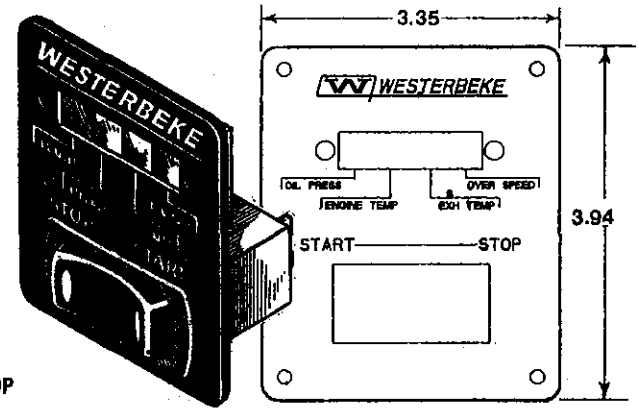
- Visually examine the unit. Look for loose or missing parts, disconnected wires, unattached hoses, and check threaded connections. Search for any gasoline leaks.
- Check load leads for correct connections as specified in the wiring diagrams.
- Examine the air inlet and outlet for air flow obstructions.
- Be sure no other generator or utility power is connected to the load lines.
- Be sure that in power systems with a neutral line that the neutral is properly grounded (or ungrounded) as the system requires, and that generator neutral is properly connected to the load neutral. In single phase systems an incomplete or open neutral can supply the wrong line-to-neutral voltage on unbalanced loads.
- Make certain the raw water thru-hull is open.

> ⚠ **CAUTION:** ***When starting the generator, it is recommended that all AC loads, especially large motors, be switched OFF until the engine has come up to speed and, in cold climates, starts to warm up. This precaution will prevent damage caused by unanticipated operation of the AC machinery and will prevent a cold engine from stalling.***

# OPERATING INSTRUCTIONS




**CAUTION:** When servicing or replacing DC components, turn off the 20 amp DC circuit breaker.




## GENERATOR CONTROL PANEL

The start/stop rocker switch is the only functional component on the generator control panel used to start and stop the generator.

The start/stop rocker switch is a three position switch with momentary contacts in the **(START)** and **(STOP)** position and a stationary contact function in the center **(NORMAL).** This position allows the generator to run once started and also enables the remote start/stop panel(s) to control the start/stop functions of the generator.

The **(START)** position starts the generator and once released reverts to the center position. The **(STOP)** position stops the engine in normal operation as well as in an emergency situation. This position opens the K2 run relay which de-energizes the engine's run circuit and shuts down the engine.

### Starting

Simply press the **(START)** switch and the generator will start. A green light will glow indicating the generator is running.

### Stopping

Depress the **(STOP)** side of the start switch, the green light will go out and the generator is stopped.

### Failure to Start

The start cycle will automatically terminate if the unit fails to start after 5-6 seconds of cranking. **Wait 20 seconds**, then repeat the start.

If the unit again fails to start, investigate the cause. Sometimes after servicing the fuel system or changing the fuel filter, air can accumulate in the fuel line or the throttle body and prevent starting.

The Schrader valves on the throttle body and the fuel cell are used to remove trapped air. This air is mixed with fuel and under high pressure. Follow the *BLEEDING THE FUEL SYSTEM* instructions in this manual.

## CHECK ENGINE LIGHT

The check engine light indicates a potential emission's control issue. Immediate action by the operator should be taken to troubleshoot and correct the emission's related issue.

## REMOTE START/STOP PANEL

The components on the panel are:

1. A three position start/stop rocker switch.
2. A green LED run indicator light on the rocker switch.
3. A four position LED fault shut down display board.

The start/stop rocker switch functions the same as the start/stop rocker switch on the generator's control panel as previously explained.

The green LED run indicator light on the rocker switch will illuminate when the start circuit is energized. It will go dim as the engine cranks and will brighten as the engine starts indicating the generator is running.

The LED fault shut down display board has four separate LED lights to display to the operator the cause of the generators automatic shut down. The four LED displays are: low oil pressure, high engine operating temperature, high exhaust temperature and engine over-speed/under-speed (flashes).

Should the generator shut down from one of these faults, the fault LED will remain illuminated. To reset the LED, the DC breaker on the control box **must** be turned **OFF** and then back **ON**.

This remote panel is a plub-in accessory and is available with a 15' to 100' wiring harness.

# BREAK-IN PROCEDURE/THE DAILY OPERATION

## BREAK-IN PROCEDURE

After the generator has been started, check for proper operation and then encourage a fast warm-up. Run the generator between 20% and 60% of full-load for the first 10 hours.

> ⚠ **CAUTION:** ***Do not attempt to break-in your generator by running without a load.***

After the first 10 hours of the generators operation, the load can be increased to the full-load rated output, then periodically vary the load.

Avoid overload at all times. An overload is signaled by smoky exhaust with reduced output voltage and frequency. Monitor the current being drawn from the generator and keep it within the generators rating. Since the generator operates at 1800 rpm to produce 60 hertz, control of the generator's engine break-in is governed by the current drawn from the generator.

To protect against unintentional overloading of the generator, the generator's output leads should be routed through a circuit breaker that is rated at the rated output of the generator.

**NOTE:** *Be aware of motor starting loads and the high current drawn required for starting motors. The starting amperage drawn can be 3 to 5 times normal running amperage. See GENERATOR INFORMATION in this manual.*

## CHECK LIST

Follow this check list each day before starting your generator.

- Record the hourmeter reading in your log (engine hours relate to the maintenance schedule).
- Visually inspect the generator for fuel, oil, or water leaks.
- Check the oil level (dipstick).
- Check the coolant level in the coolant recovery tank.
- Check your fuel supply.
- Check the starting batteries (weekly).
- Check drive belts for wear and proper tension (weekly).
- Check for abnormal noise such as knocking, vibration and blow-back sounds.
- Check drive belts for wear and proper tension (weekly).
- Confirm exhaust smoke:
  When the engine is cold – white smoke.
  When the engine is warm – almost smokeless.
  When the engine is overloaded – some black smoke.

**NOTE:** *Some unstable running may occur in a cold engine. This condition should lessen as normal operating temperature is reached and loads are applied.*

> ⚠ **CAUTION:** ***Do not operate the generator for long periods of time without a load being placed on the generator.***

## GENERATOR ADJUSTMENTS

Once the generator has been placed in operation, there may be governor adjustments required for engine speed (hertz) during the engine's break-in period (first 50 hours) or after this period.See *ENGINE SPEED (HERTZ) ADJUSTMENT* under *ENGINE ADJUSTMENTS).*

**NOTE:** *After the first 50 hours of generator operation, check the maintenance schedule for the 50 hour service check.*

> ⚠ **WARNING: VENTILATION**
>
> Gasoline vapors can explode. Before starting the engine, operate the blower for at least four minutes and check both the engine compartment and bilge for gasoline vapors. Run the blower below cruising speed.

# SAFETY SHUTDOWN SENSORS AND SWITCHES

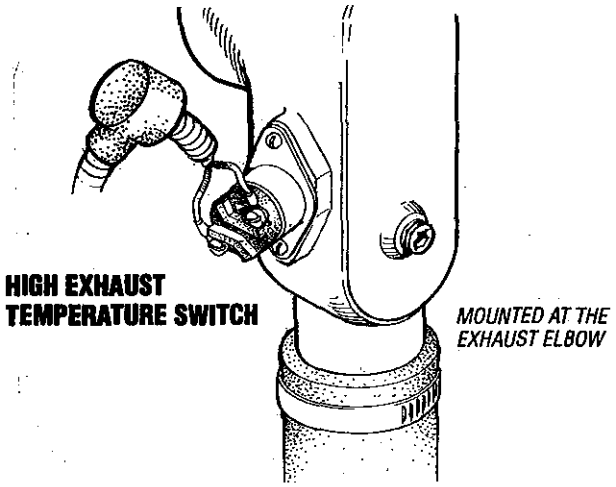
## SAFETY SHUTDOWN SWITCH/SENSORS

The engine is protected by four automatic shutdown circuits. Should a shutdown occur, ***do not attempt to restart without finding and correcting the cause.*** Refer to the heading *Engine starts, runs and then shuts down* in the *ENGINE TROUBLESHOOTING* section of this manual.

The following is a description of these automatic shutdown circuits:

### High Exhaust Temperature Switch

An exhaust temperature switch is located on the water injected exhaust elbow. Normally closed, this switch will open and the ECU will interpret this as a high exhaust temperature and open the K2 run relay, stopping the generator. The exhaust temperature LED on the panel will illuminate. The switch opens at 260-270F (127-132C). This switch resets (contacts close) at approximately 225F (107C).

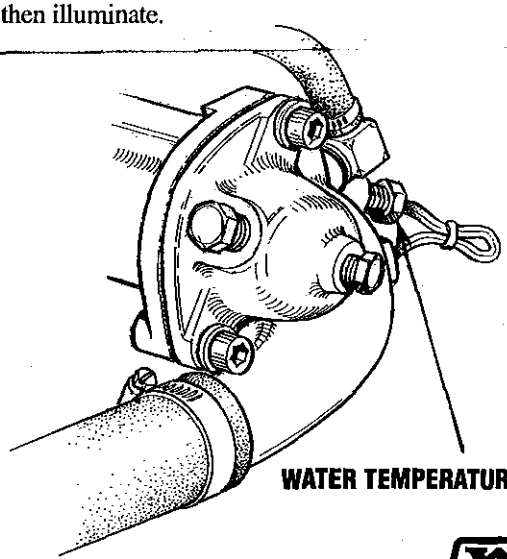


**HIGH EXHAUST TEMPERATURE SWITCH**

*MOUNTED AT THE EXHAUST ELBOW*

### Water Temperature Sensor

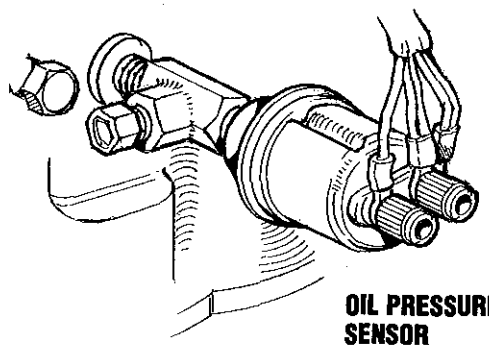
A water temperature sensor is located at the thermostat housing. This sensor sends a DC voltage to the ECU that it interprets as engine antifreeze coolant temperature. Should this voltage reach a set value, the ECU will interpret this as high antifreeze coolant temperature and open the K2 run relay, stopping the generator. The overheat LED on the panel will then illuminate.



**WATER TEMPERATURE SENSOR**

### Oil Pressure Sensor

An oil pressure sensor is located off the engines oil gallery. Oil pressure on the sensor affects the DC voltage through the sensor to the ECU. Should the voltage reach a preset value, the ECU will interpret this as a low oil pressure issue and open the K2 run relay, stopping the generator. The oil pressure LED on the panel will illuminate.



**OIL PRESSURE SENSOR**

### Engine DC Circuit Breaker

The generator's engine DC circuit is protected by a rocker type DC 20 amp breaker mounted on the control box. *This also serves as an Emergency Stop Switch.* Excessive DC current draw or DC electrical overload anywhere in the instrument panel wiring or engine wiring will cause the breaker to trip to the OFF position. In this event, the DC power to the ECU will be interrupted, stopping the generator. No panel LED will illuminate. Check and repair the source of the problem. After repairing the fault, reset the breaker and restart the generator.

### High/Low RPM Shutdown

Should the generator's RPM go above 20% of the specified 1800 rpm @ 60 Hz/1500 rpm @ 50 Hz, the ECU will shut the engine down on an over speed fault and illuminate the **over speed** LED on the control panel and remote start/stop panel when installed

Should the generator's RPM fall below 20% of the specified 1800 rpm @ 60 Hz/1500 rpm @ 50 Hz, the ECU will shut the engine down on an under speed fault and this will cause the **over speed** LED to **flash**.

The OBD (On Board Diagnostic) will also show these faults.

# MAINTENANCE SCHEDULE

**⚠ WARNING:** ***Never attempt to perform any service while the engine is running. Wear the proper safety equipment such as goggles and gloves, and use the correct tools for each job. Disconnect the battery terminals when servicing any of the engine's DC electrical equipment.***

SAFE CO *Maintenance items that are very important to the proper operation of "Safe CO" generators.*

| SCHEDULED MAINTENANCE | CHECK EACH DAY | HOURS OF OPERATION | | | | | | | MAINTENANCE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | | 50 | 100 | 250 | 500 | 750 | 1000 | 1250 | |
| **Fuel Supply** | ☐ | | | | | | | | Unleaded gasoline with octane rating of 89 of higher |
| **Fuel/Water Separator** | ☐ | | | | | | | | Check for water and dirt in fuel (drain/replace filter if necessary). |
| **Engine Oil Level** | ☐ | | | | | | | | Oil level should indicate between MAX. and LOW on dipstick. |
| **Coolant Level** | ☐ | | | | | | | | Check at recovery tank; if empty, check at manifold. Add coolant if needed. |
| **Drive Belts** | ☐ weekly | | | | | | | | Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt edges for wear. |
| **Visual Inspection of Engine** | ☐ | **NOTE:** *Keep engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.* | | | | | | | Check for fuel, oil and water leaks. Inspect wiring and electrical connections. Keep bolts & nuts tight. Check for loose belt tension. |
| **Sparks Plugs** SAFE CO | | ☐ | | ☐ | ☐ | ☐ | ☐ | ☐ | Check gap, inspect for burning and corrosion. |
| **Starting Batteries (and House Batteries)** | ☐ weekly | | | | | | | | Every 50 operating hours check electrolyte levels and make sure connections are very tight. Clean off excessive corrosion. |
| **Engine Oil** | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Initial engine oil and filter change at 50 hours, then change both every 100 hours. |
| **Generator** | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Check that AC connections are clean and secure with no chafing-see *GENERATOR INFORMATION.* |
| **Fuel Lift Pump** | | ☐ | | | | | | | Periodically inspect for leaks, electrical connections are clean and tight. |
| **Air Screen** SAFE CO | | ☐ | | | | | | | Clean at 50 hrs., then every 100 hours. |
| **Exhaust System** | | ☐ | | ☐ | | ☐ | | ☐ | Initial check at 50 hours, then every 250 hours. Inspect for leaks. Check anti-siphon valve operation. Check the exhaust elbow for carbon and/or corrosion buildup on inside passages; clean and replace as necessary. Check that all connections are tight. |
| **Engine Hoses** | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Hose should be hard & tight. Replace if hoses become spongy. Check and tighten all hose clamps. |
| **Raw Water Pump** | | | | ☐ | | ☐ | | ☐ | Remove the pump cover and inspect for wear. Inspect impeller, cam and wear plate. Replace gasket. Lubricate impeller when reassembling. |
| **Heat Exchanger** | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Clean or replace anode. Open heat exchanger end cap and clean out debris. Remove every 1000 hours for professional cleaning and pressure testing. |
| **Coolant System** | | | | | ☐ | | ☐ | | Drain, flush, and refill cooling system with appropriate antifreeze mix. |
| **Fuel Filter** | | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Change every 250 operating hours. |
| **Inlet Fuel Filter** | | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Change every 250 operating hours. |

*(continued)*

**⚠ CAUTION:** ***When servicing/replacing DC components, turn off the 20 amp DC circuit breaker.***

# MAINTENANCE SCHEDULE

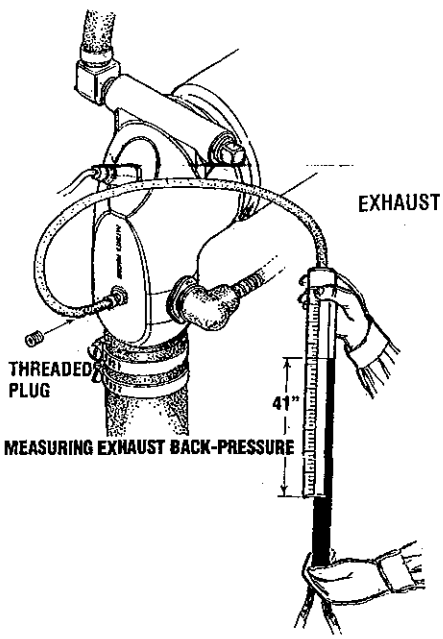
**CAUTION:** When servicing or replacing DC components, turn off the 20 amp DC circuit breaker.

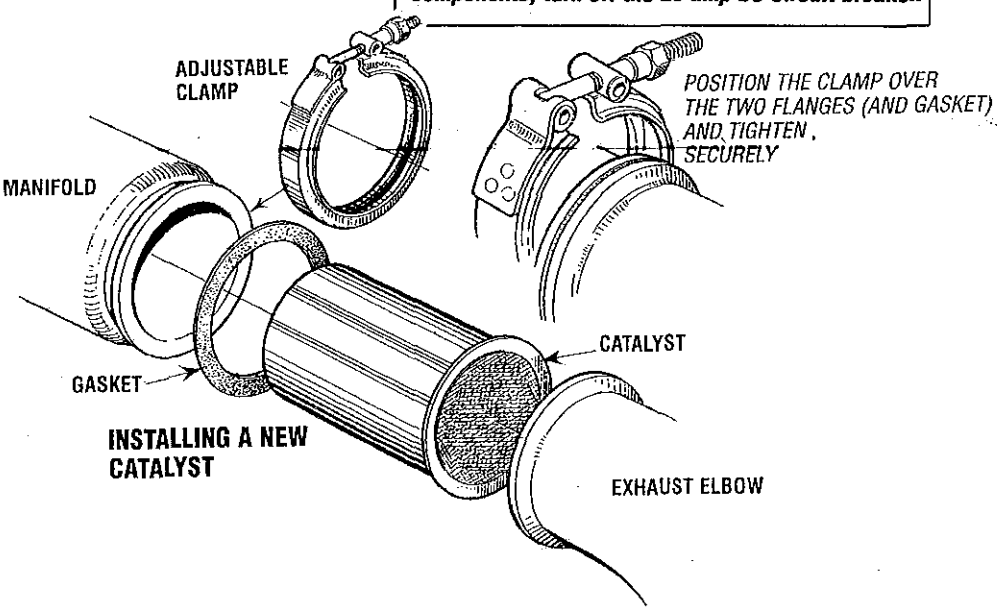
**NOTE:** *Use the engine hourmeter gauge to log your engine hours or record your engine hours by running time.*

| SCHEDULED MAINTENANCE | CHECK EACH DAY | HOURS OF OPERATION | | | | | | | MAINTENANCE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | | 50 | 100 | 250 | 500 | 750 | 1000 | 1250 | |
| *Starter Motor | | | | | ☐ | | | ☐ | Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive. |
| Distributor | | ☐ | | | ☐ | | | | Check ignition timing. Check condition of distributor cap and rotor. |
| *Engine Cylinder Compression and Valve Clearances | | | | | ☐ | | | ☐ | Incorrect valve clearance will result in poor engine performance, check compression pressure and timing and adjust valve clearances. |
| *Engine Timing Belt | | | | | ☐ | | | | Remove and replace every 1000 hours. **NOTE:** *Failure to replace the timing belt at the recommended interval could result in timing chain failure resulting in major damage to the engine.* |
| *Exhaust Elbow | | | | | ☐ | | | | Test exhaust elbow for casting integrity. Replace if casting is corroded or deteriorated. **NOTE:** *A defective exhaust elbow can cause carbon monoxide leakage!* |
| Catalytic Converter | | | | | | | ☐ | | Remove water injected exhaust elbow and visually inspect. Replace every 2000 hours. |
| *Exhaust System Back Pressure | | | | | ☐ | | | | Perform back pressure test to ensure system is not developing restrictions that will increase pressure above 1.5 PSI or 41 inches of water column at full operating amperage load. Correct as needed. |
| Catalyst | | | | | | | ☐ | | Remove water injected exhaust elbow and visually inspect every 2000 hours. Replace as needed. |
| Oxygen Sensor | | | | | | | ☐ | | Inspect every 1000 hours. Replace every 2000 hours. |
| CO in Exhaust | | | | | | | ☐ | | Sample with CO analyzer. |

*WESTERBEKE recommends this service be performed by an authorized mechanic.

**⚠ CAUTION:** ***When servicing/replacing DC components, turn off the 20 amp DC circuit breaker.***



# COOLING SYSTEM

## DESCRIPTION

Westerbeke marine engines are designed and equipped for fresh water cooling. Heat produced in the engine by combustion and friction is transferred to fresh water coolant which circulates throughout the engine. This circulating fresh water coolant cools the engine block, its internal moving parts and the engine oil. The heat is transferred externally from the fresh water coolant to raw water by means of a heat exchanger, similar in function to an automotive radiator. Raw water flows through the tubes of the heat exchanger while fresh water coolant flows around the tubes; engine heat transferred to the fresh water coolant is conducted through the tube walls to the raw water which is then pumped into the exhaust system where finally it is discharged overboard. In other words, the engine is cooled by fresh water coolant, this coolant is cooled by raw water, and the raw water carries the transferred heat overboard through the exhaust system. The fresh water coolant and raw water circuits are independent of each other. Using only fresh water coolant within the engine allows the cooling water passages to stay clean and free from harmful deposits.

## FRESH WATER CIRCUIT

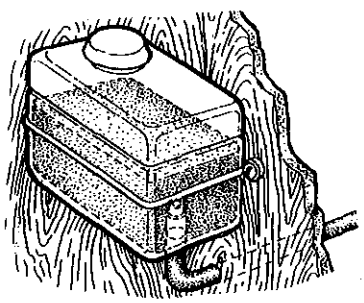
**NOTE:** *Refer to* ENGINE COOLANT *section for the recommended antifreeze and water mixture to be used as the fresh water coolant.*

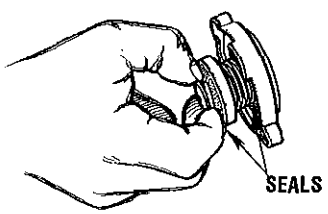
Fresh water coolant is pumped through the engine by a circulating pump, absorbing heat from the engine. The coolant then passes through the thermostat into the manifold, to the heat exchanger where it is cooled and returned to the engine block via the suction side of the circulating pump. When the engine is started cold, external coolant flow is prevented by the closed thermostat (although some coolant flow is bypassed around the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing full flow of the engine's coolant to flow unrestricted to the external portion of the cooling system.

### Coolant Recovery Tank

The coolant recovery tank allows for engine coolant expansion and contraction during engine operation, without the introduction of air into the cooling system. This tank should be located at or above the engine manifold level and should be easily accessible.

**NOTE:** *Periodically check the condition of the manifold pressure cap, its rubber seals and the vacuum return valve. Ensure the passage from the filler neck to the recovery tank connection is kept clear.*






## CHANGING COOLANT

The engine's coolant must be changed according to the *MAINTENANCE SCHEDULE*. If the coolant is allowed to become contaminated, it can lead to overheating problems.

> ⚠ **CAUTION:** ***Proper cooling system maintenance is critical; a substantial number of engine failures can be traced back to cooling system corrosion.***

Drain the engine coolant by loosening the drain plug on the engine block and opening the manifold pressure cap. Flush the system with fresh water, then start the refill process.

**NOTE:** *The drain plug on the heat exchanger can also be used to drain engine coolant.*

> ⚠ **WARNING:** ***Beware of the hot engine coolant. Wear protective gloves.***

### Refilling the Coolant

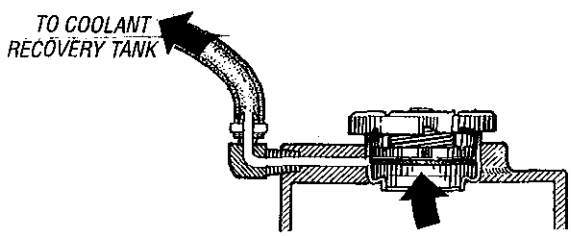
After replacing the engine block drain plug, close the heat exchanger's coolant petcock. Then run the engine at idle and slowly pour clean, premixed coolant into the manifold.

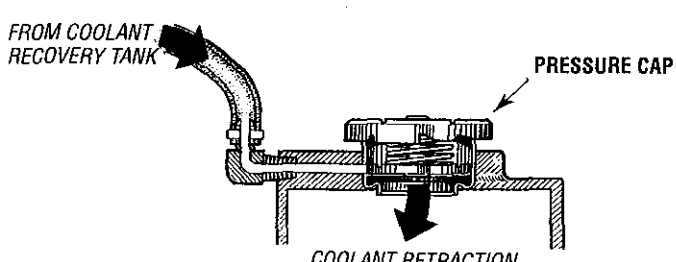
**NOTE:** *Open the air-bleed petcock on the heat exchanger. When a steady flow of coolant appears at the petcock, close the petcock and fill the system until the manifold remains full.*

Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and install the manifold pressure cap.

Remove the cap on the coolant recovery tank and fill with coolant mix to halfway between LOW and MAX and replace the cap. Run the engine and observe the coolant expansion flow into the recovery tank.

After checking for leaks, stop the engine and allow it to cool. Coolant should draw back into the cooling system as the engine cools down. Add coolant to the recovery tank if needed. Clean up any spilled coolant.

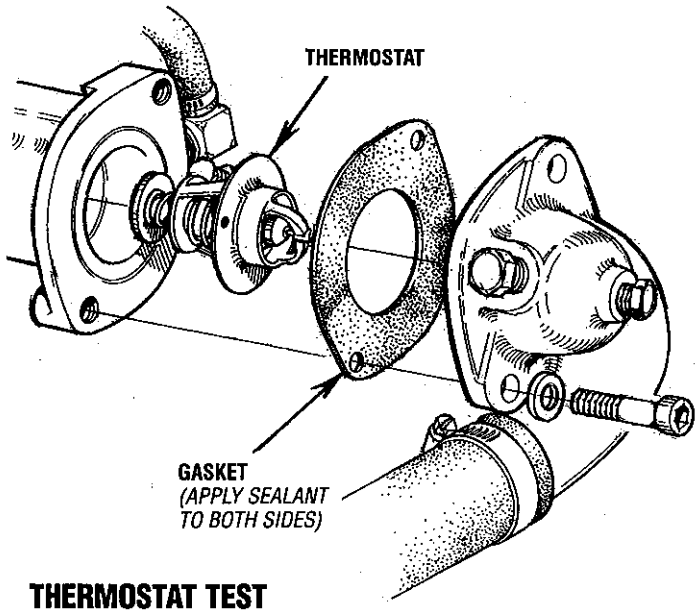


# COOLING SYSTEM

## THERMOSTAT

A thermostat controls the coolant temperature as the coolant continuously flows through the closed cooling circuit. When the engine is first started the closed thermostat prevents coolant from flowing (some coolant is by-passed through the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens. The thermostat is accessible and can be checked, cleaned, or replaced easily. Carry a spare thermostat and gasket.

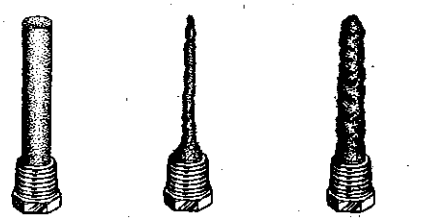



## THERMOSTAT TEST

If you suspect a faulty thermostat, place it in a pan of water and bring to a boil. A working thermostat should open about 1/2"

## ZINC ANODE

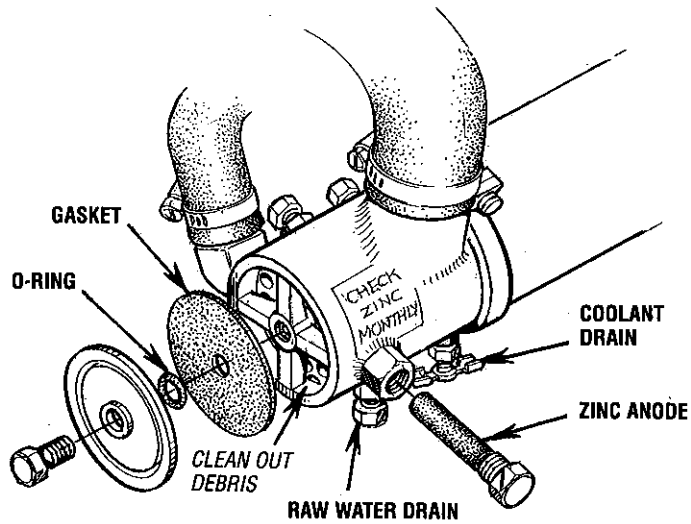
A zinc anode (or pencil) is located in the raw water cooling circuit within the heat exchanger. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the raw water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board.




**NOTE:** *Electrolysis is the result of each particular installation and vessel location, not that of the generator.*

If the zinc anode needs replacement, hold the hex boss into which the zinc anode is threaded with a wrench while loosening the anode with another wrench. This prevents the hex boss from possibly tearing off the exchanger shell. After removing the zinc, note the condition of it. If the zinc is in poor condition, there are probably a lot of zinc flakes within the exchanger. Remove the end of the heat exchanger and clean the inside of all zinc debris. Always have a spare heat exchanger end gasket in case the present one becomes damaged when removing the end cover. Replace the sealing gasket (refer to your engine model's heat exchanger end gasket part number), O-ring, cover, and install a new zinc anode.

**NOTE:** *The threads of the zinc anodes are pipe threads and do not require sealant. sealant should not be used as it may insulate the zinc from the metal of the heat exchanger housing preventing electrolysis action on the zinc.*




## HEAT EXCHANGER

Cool raw water flows through the inner tubes of the heat exchanger. As the engine coolant passes around these tubes, the heat of the internal engine is conducted to the raw water which is then pumped into the exhaust system and discharged. The engine coolant (now cooled) flows back through the engine and the circuit repeats itself.

The engine coolant and raw water are independent of each other; this keeps the engine's water passages clean from the harmful deposits found in raw water.

### Heat Exchanger Service

After approximately 1000 hours of operation, remove, clean and pressure test the engine's heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

**NOTE:** *Operating in silty and/or tropical waters may require that a heat exchanger cleaning be performed more often than every 1000 hours.*

## RAW WATER INTAKE STRAINER

**NOTE:** *Always install the strainer at or below the waterline so the strainer will always be self-priming.*

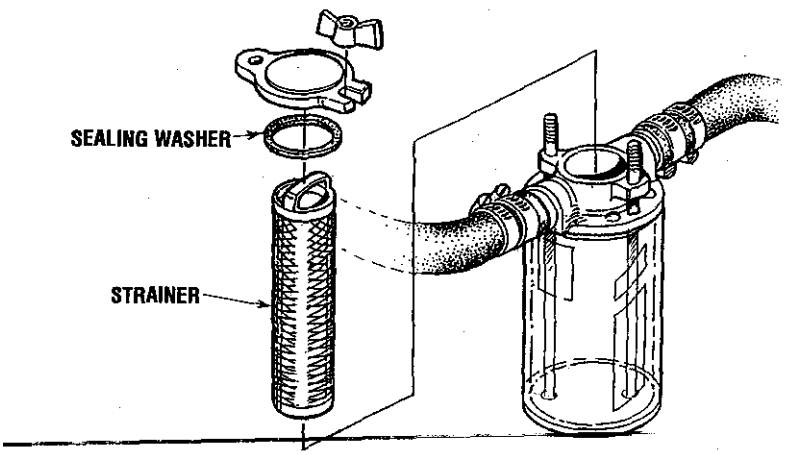
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

Perform the following maintenance after every 100 hours of operation:

1. **Close the raw water seacock.**
2. Remove and clean the strainer filter.
3. Clean the glass.
4. Replace the sealing washer if necessary.
5. Reassemble and install the strainer.
6. **Open the seacock.**
7. Run the engine and check for leaks.

**NOTE:** *Also follow the above procedure after having run hard aground.*

If the engine temperature gauge ever shows a higher than normal reading, the cause may be that silt, leaves or grass may have been caught up in the strainer, slowing the flow of raw water through the cooling system.



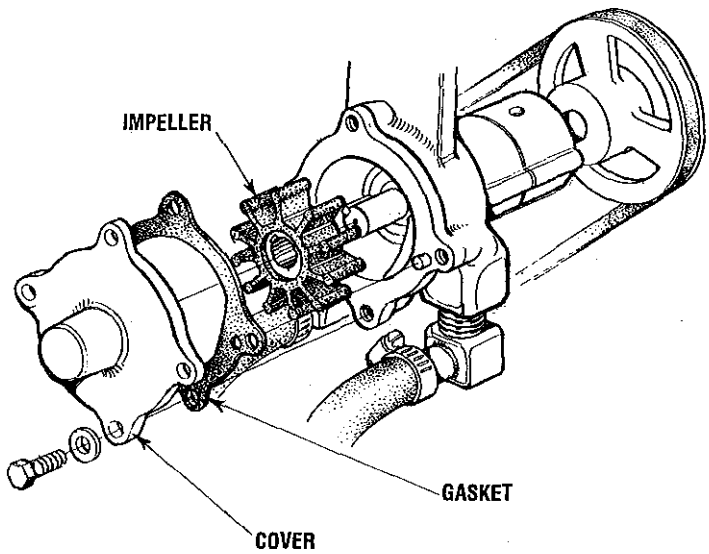

**RAW WATER INTAKE STRAINER OWNER INSTALLED (TYPICAL)**

## RAW WATER PUMP

The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a Neoprene impeller. The impeller has flexible blades which wipe against a curved cam plate within the impeller housing, producing the pumping action. **On no account should this pump be run dry.** There should always be a spare impeller and impeller cover gasket aboard (an impeller kit). Raw water pump impeller failures occur when lubricant (raw water) is not present during engine operation. Such failures are not warrantable, and operators are cautioned to make sure raw water flow is present at start-up. The raw water pump should be inspected periodically for broken or torn impeller blades. See *MAINTENANCE SCHEDULE.*

### Changing the Raw Water Pump Impeller

Close the raw water intake valve. Remove the pump cover and, with the aid of two small screwdrivers, carefully pry the impeller out of the pump. Install the new impeller and gasket. Move the blades to conform to the curved cam plate and push the impeller into the pumps housing. When assembling, apply a thin coating of lubricant to the impeller and gasket. Open the raw water intake valve.




**⚠ CAUTION:** ***If any of the vanes have broken off the impeller, they must be found to prevent blockage in the cooling circuit. They often can be found in the heat exchanger.***

# FUEL SYSTEM

## GASOLINE

Use ***unleaded*** 89 octane or higher gasoline. When fueling, follow U.S. Coast Guard regulations, close off all hatches and companionways to prevent fumes from entering the boat, and ventilate after fueling.

**NOTE:** *The generator compartment should have a gasoline fume detector/alarm properly installed and working.*

## GASOLINE/WATER SEPARATOR AND FILTER

A primary fuel filter of the water separating type must be installed between the fuel tank and the engine to remove water and other contaminant's from the fuel before they can be carried to the fuel system on the engine.

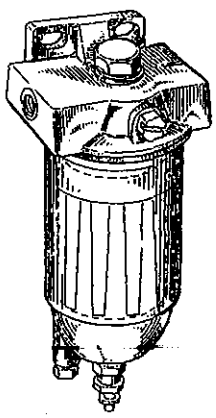
These gasoline filters must have *metal* bowls (not "see-through") to meet U.S. Coast Guard requirements. The metal bowls have drain valves to use when checking for water and impurities.

## FUEL PUMP

Periodically check the fuel connections to and out of the pump and make sure that no leakage is present and that the fittings are tight and secure. The engine mounted fuel pump is maintenance free.

## ENGINE FUEL FILTER

Periodically check the fuel connections and the filter bowl for leakage. Replace the filter element after the first 50 hours. See the *MAINTENANCE SCHEDULE.*



**OWNER INSTALLED FUEL WATER SEPERATOR**

**(WESTERBEKE PART #49602)**

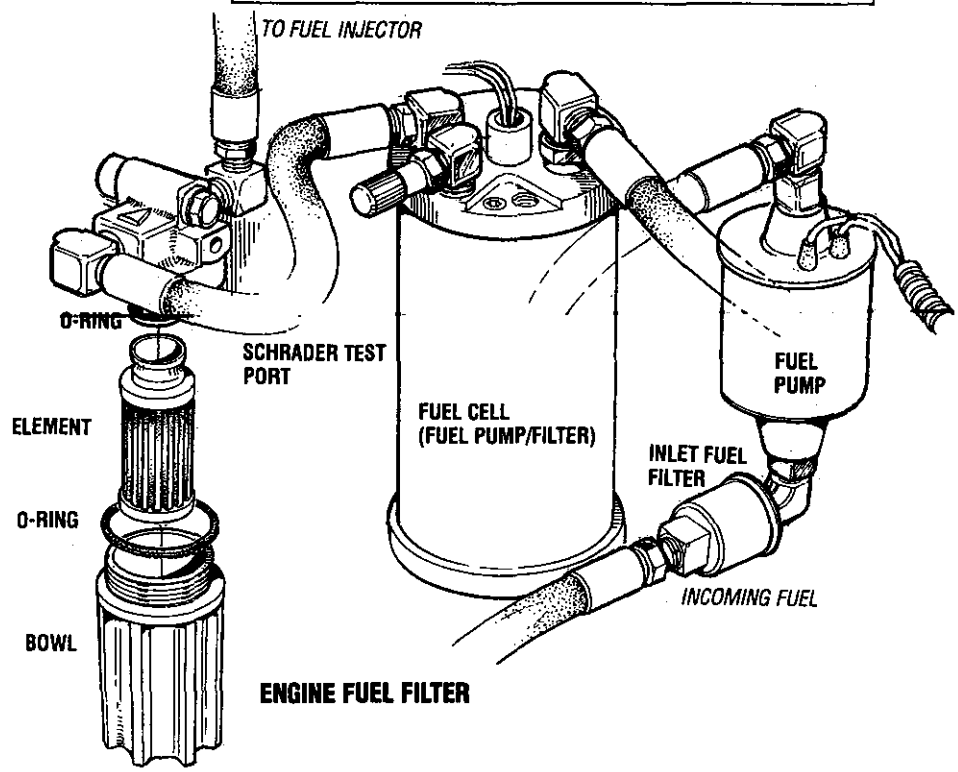
## Changing Filter Element

1. Shut off the fuel supply.
2. Ensure there is no pressure in the fuel system by bleeding off any existing pressure using a Schrader valve on the throttle body and the fuel cell. Use a pressure testing kit as shown below.
3. Unscrew the fuel bowl from the housing and allow the bowl to come away from the housing.
4. Remove and replace the filter element and clean the bowl.
5. Inspect both O-rings. Replace if necessary.
6. Press on a new filter and replace the filter bowl.
7. Open the fuel supply. Inspect for leaks.

## INLET FUEL FILTER

1. Shut off the fuel supply to the generator. Disconnect the fuel supply line to the inlet filter and unscrew the filter from the pump inlet. Take care to catch any fuel that may be present.
2. Thread on the replacement inlet filter and connect the fuel supply line. Use care when connecting and tightening the fuel supply line so as not to distort the inlet filter.
3. Turn on the fuel supply to the generator and start the generator. Ensure that there are no leaks.

**⚠ WARNING:** ***Shut off the fuel valve at the tank when servicing the fuel system. Take care in catching any fuel that may spill.***




**ENGINE FUEL FILTER**

## BLEEDING THE FUEL SYSTEM

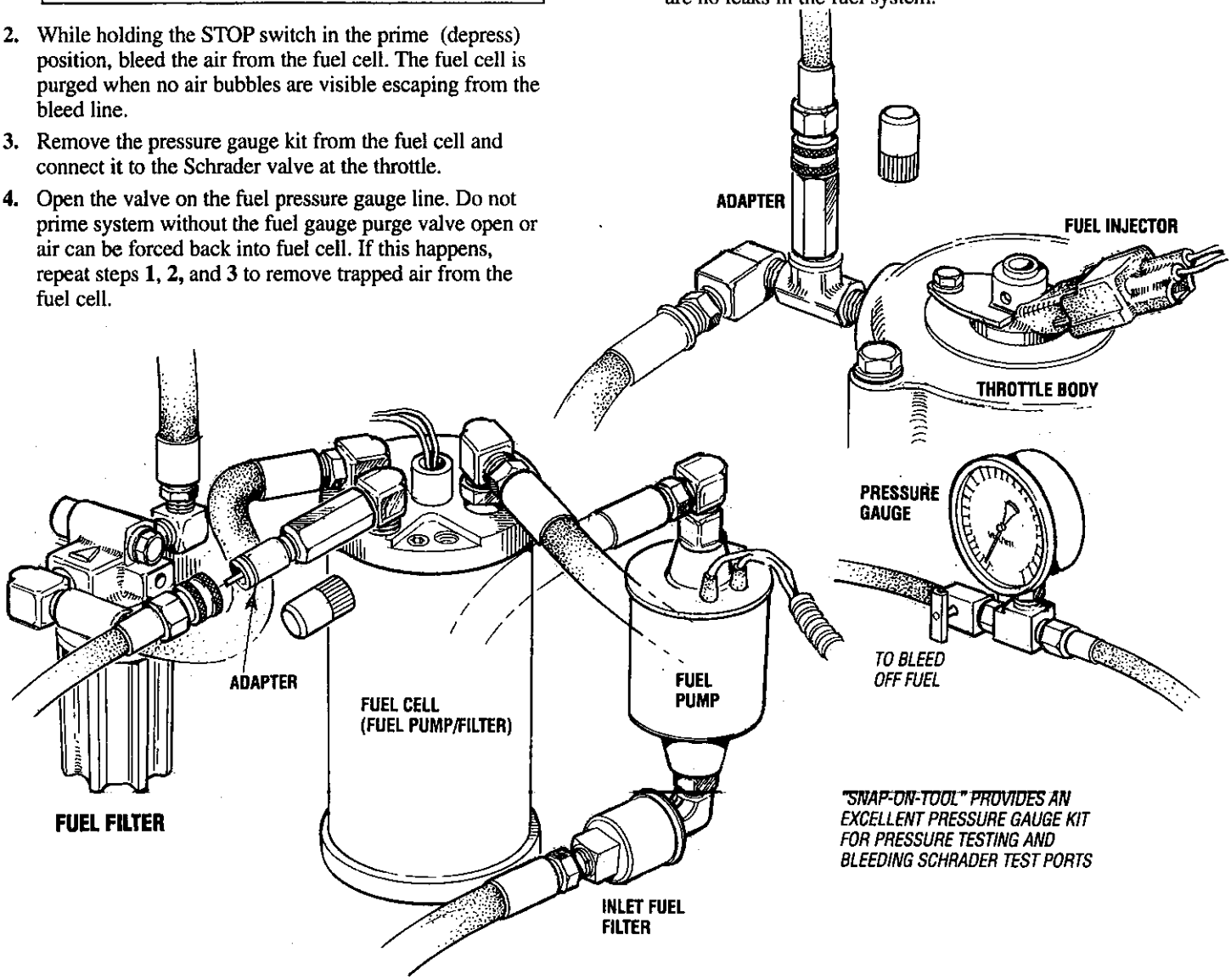
If the engine cranks but fails to start or starts and then shuts down, there may be air in the fuel system. Use the following procedure to purge air from the fuel system.

1. Connect a fuel pressure gauge kit (Snap-On MT 3378) or equivalent to the Schrader port on the fuel cell.

> ⚠ **CAUTION:** ***Follow the manufacturers instructions for the safe use of the pressure gauge kit when purging high pressure fuel systems.***

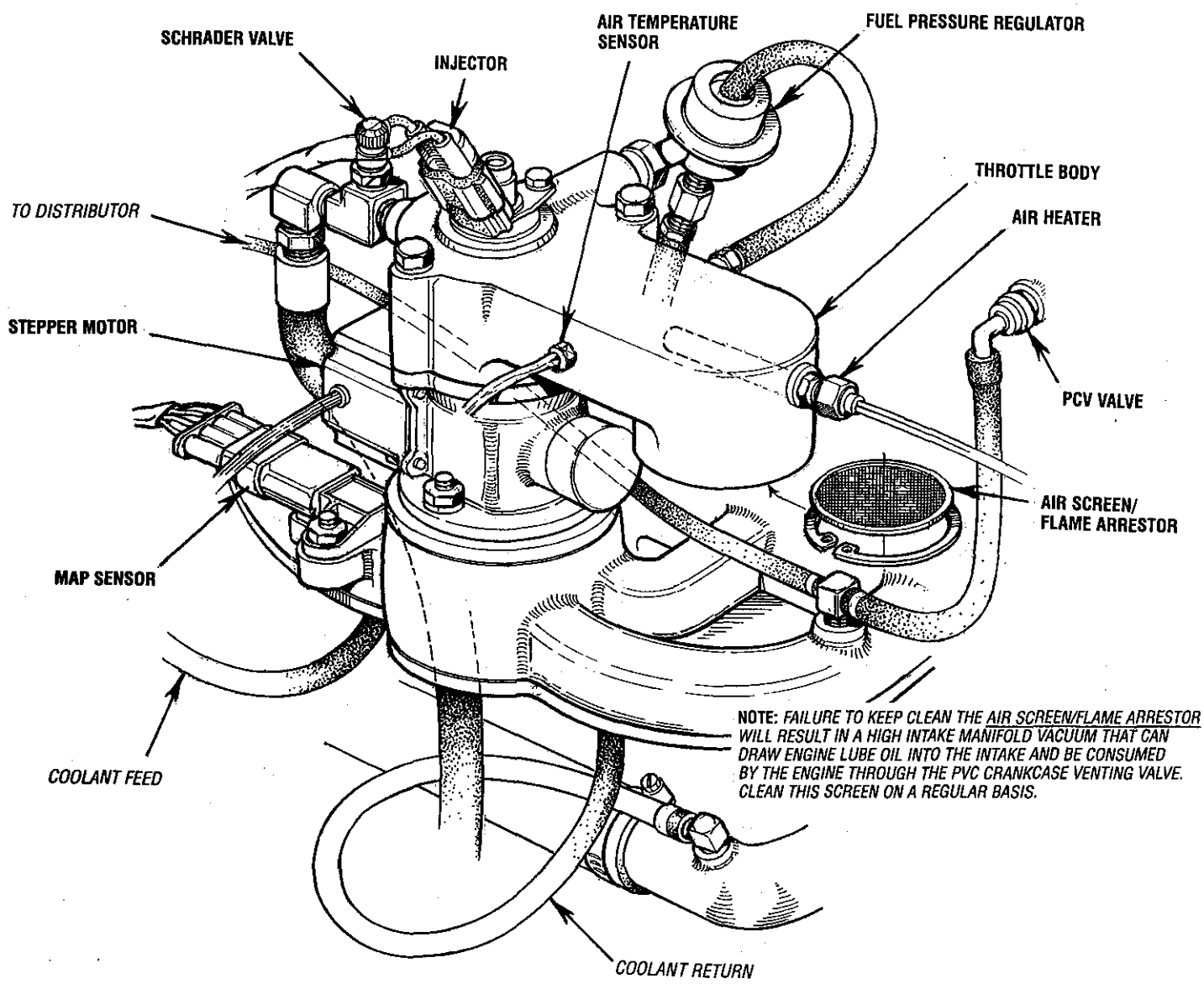
2. While holding the STOP switch in the prime (depress) position, bleed the air from the fuel cell. The fuel cell is purged when no air bubbles are visible escaping from the bleed line.
3. Remove the pressure gauge kit from the fuel cell and connect it to the Schrader valve at the throttle.
4. Open the valve on the fuel pressure gauge line. Do not prime system without the fuel gauge purge valve open or air can be forced back into fuel cell. If this happens, repeat steps **1, 2,** and **3** to remove trapped air from the fuel cell.
5. Repeat step **2**, this time purging the air completely from the throttle body. The pressure should be 40psi in the throttle body after purging the system.

   **NOTE:** *The system can develop 40psi without being fully purged. The system is only fully purged when no bubbles are visible in the purge line.*
6. Remove the pressure gauge set, and cap all Schrader valves.
7. Insure that all wire connections are secure and that there are no leaks in the fuel system.




**BLEEDING THE FUEL SYSTEM**

# ELECTRONIC FUEL INJECTION (EFI)


SCHRADER VALVE
INJECTOR
AIR TEMPERATURE SENSOR
FUEL PRESSURE REGULATOR
THROTTLE BODY
TO DISTRIBUTOR
AIR HEATER
STEPPER MOTOR
PCV VALVE
AIR SCREEN/ FLAME ARRESTOR
MAP SENSOR
COOLANT FEED
NOTE: FAILURE TO KEEP CLEAN THE AIR SCREEN/FLAME ARRESTOR WILL RESULT IN A HIGH INTAKE MANIFOLD VACUUM THAT CAN DRAW ENGINE LUBE OIL INTO THE INTAKE AND BE CONSUMED BY THE ENGINE THROUGH THE PVC CRANKCASE VENTING VALVE. CLEAN THIS SCREEN ON A REGULAR BASIS.
COOLANT RETURN

## DESCRIPTION

The above illustration shows the throttle body assembly attached to the intake manifold.

An electronic control unit (ECU) controls the fuel injection and throttle actuator.

The ECU is supplied with electrical signals it interprets as engine operating conditions from sensors that monitor intake air temperature, engine coolant temperature, map sensor (intake manifold absolute pressure), engine rpm, battery voltage and distributor cam signal.

The ECU interprets this information to determine the appropriate injector pulse rate and throttle opening position.

A high pressure fuel pump supplies fuel to the area around the injector and regulator maintains the fuel pressure in that area at 35 - 40 PSI.

The injector is a solenoid operated pintle valve that meters fuel into the intake manifold depending on engine operating conditions and generator amperage load as determined by the ECU.

Air flow into the intake manifold is controlled by the ECU operation of the throttle plate via the actuator. Throttle plate positioning for proper air flow into the engine is accomplished through the ECU interpretation of engine operating conditions. The Schrader valve is used to monitor/check fuel pressure around the fuel injector.

# ENGINE LUBRICATING OIL

## ENGINE OIL

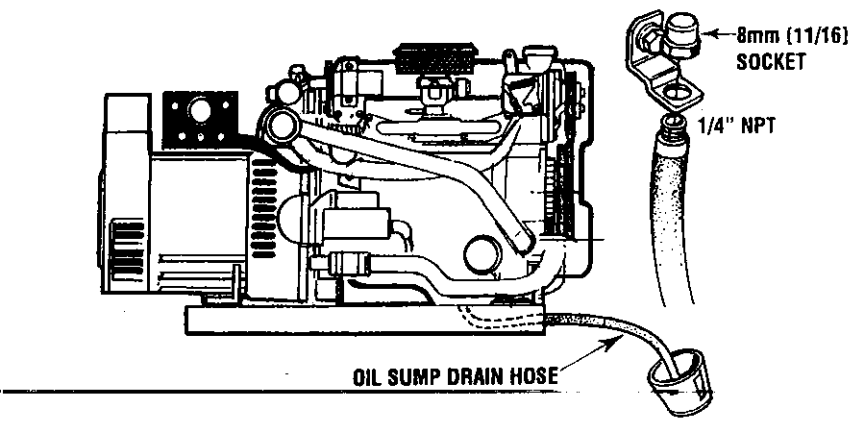
Use a heavy duty engine oil with an API classification of SJ. Change the engine oil after an initial 50 hours of break-in operation, and every 100 hours of operation thereafter. For recommended oil viscosity, see the following chart:

| Operating Temperature | Oil Viscosity |
|---|---|
| Above 68° F (20° C) | SAE 30, 10W-30 or 15W-40 |
| 41° - 68° F (5°-20° C) | SAE 20, 10W-30 or 15W-40 |
| Below 41° F (5° C) | SAE 10W-30 or 15W-40 |

## ENGINE OIL CHANGE

The engine oil should be warm. Remove the oil drain hose from its attachment bracket and lower it into a container and allow the oil to drain, or attach a pump to the end of the drain hose and pump the old oil out. Make sure the oil drain hose is properly secured in its holder after all of the old oil has been drained.

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic if water is present in the oil. Raw water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning through the raw water cooling circuit into the exhaust, filling into the engine.




> ⚠ **WARNING:** ***Used engine oil contains harmful contaminants. Avoid prolonged skin contact. Clean skin and nails thoroughly using soap and water. Launder or discard clothing or rags containing used oil. Discard used oil properly.***

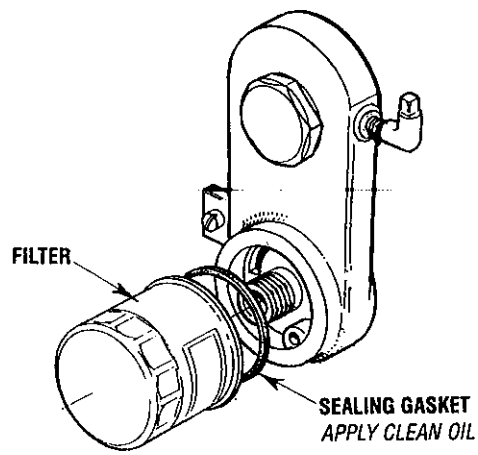
## REPLACING THE OIL FILTER

When removing the used oil filter, you may find it helpful to punch a hole in the upper and lower portion of the old filter to drain the oil into a container before removing it. This helps to lessen spillage. An automotive filter wrench should be helpful in removing the old oil filter. Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil that's in the filter. Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket comes off with the old oil filter. If this rubber sealing gasket remains sealed against the oil filter adapter, gently remove it. When installing the new oil filter element, wipe the filter gasket's sealing surface on the oil filter adapter free of oil and apply a thin coat of clean engine oil to the rubber sealing gasket on the oil filter. Screw the filter onto the threaded oil filter stub, and tighten the filter firmly by hand.

**NOTE:** *Use genuine WESTERBEKE oil filters. Generic filters are not recommended.*

## REFILLING THE OIL SUMP

Add fresh oil through the valve cover. After refilling the oil, run the engine for a few moments while checking the engine's oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and then stop the engine. Then check the quantity of oil with the lube oil dipstick. Fill to, but not over, the FULL mark on the dipstick.



# OIL PRESSURE

**NOTE:** *WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.*

## DESCRIPTION

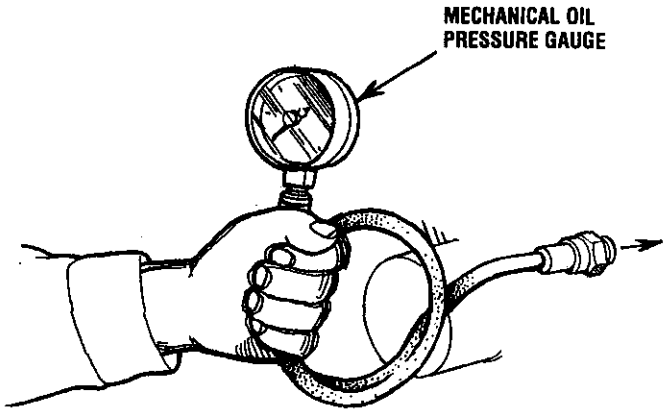
The lubricating system is a pressure feeding system using an oil pump. The engine oil is drawn from the oil sump by the oil pump, which drives the oil, under pressure, through the oil filter and various lubricating points in the engine. The oil then returns to the oil sump to repeat the continuous cycle. When the oil pressure exceeds the specified pressure, the oil pushes open the relief valve in the oil pump and returns to the oil sump, keeping the oil pressure within its specified range.

## TESTING OIL PRESSURE

To test the oil pressure, remove the oil pressure sender and install a mechanical oil pressure gauge in its place. After warming up the engine, set the engine speed at 1800 rpm and read the oil pressure gauge.

**Oil Pressure** **Between 55 and 76 psi at 1800 rpm.**

**Note:** *A newly started (cold) engine may have an oil pressure up to 70 or 80 psi. A warmed engine can have an oil pressure as low as 40 psi. Oil pressure will vary depending on the load placed on the generator.*

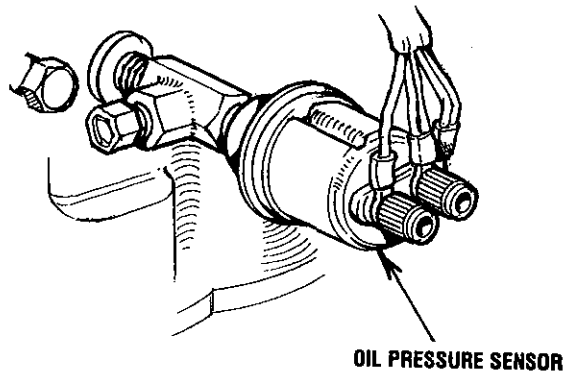



## LOW OIL PRESSURE

The specified safe minimum oil pressure is 15.0 – 10.0 psi A gradual loss of oil pressure usually indicates a worn/faulty oil pressure relief valve or worn bearings/bushings. For additional information on low oil pressure readings, see the ENGINE TROUBLESHOOTING chart.

## OIL PRESSURE SENSOR

The generator's drive engine has an oil pressure sensor mounted off the oil gallery. This sensor, during generator operation, is sending a DC voltage to the ECU that it interprets as oil pressure. Should the engine's oil pressure drop below a safe minimum, the DC voltage to the ECU will drop. The ECU will interpret this as a low oil pressure fault and stop the generator.



# OPTIONAL REMOTE OIL FILTER (PN #052537)

## INSTALLATION

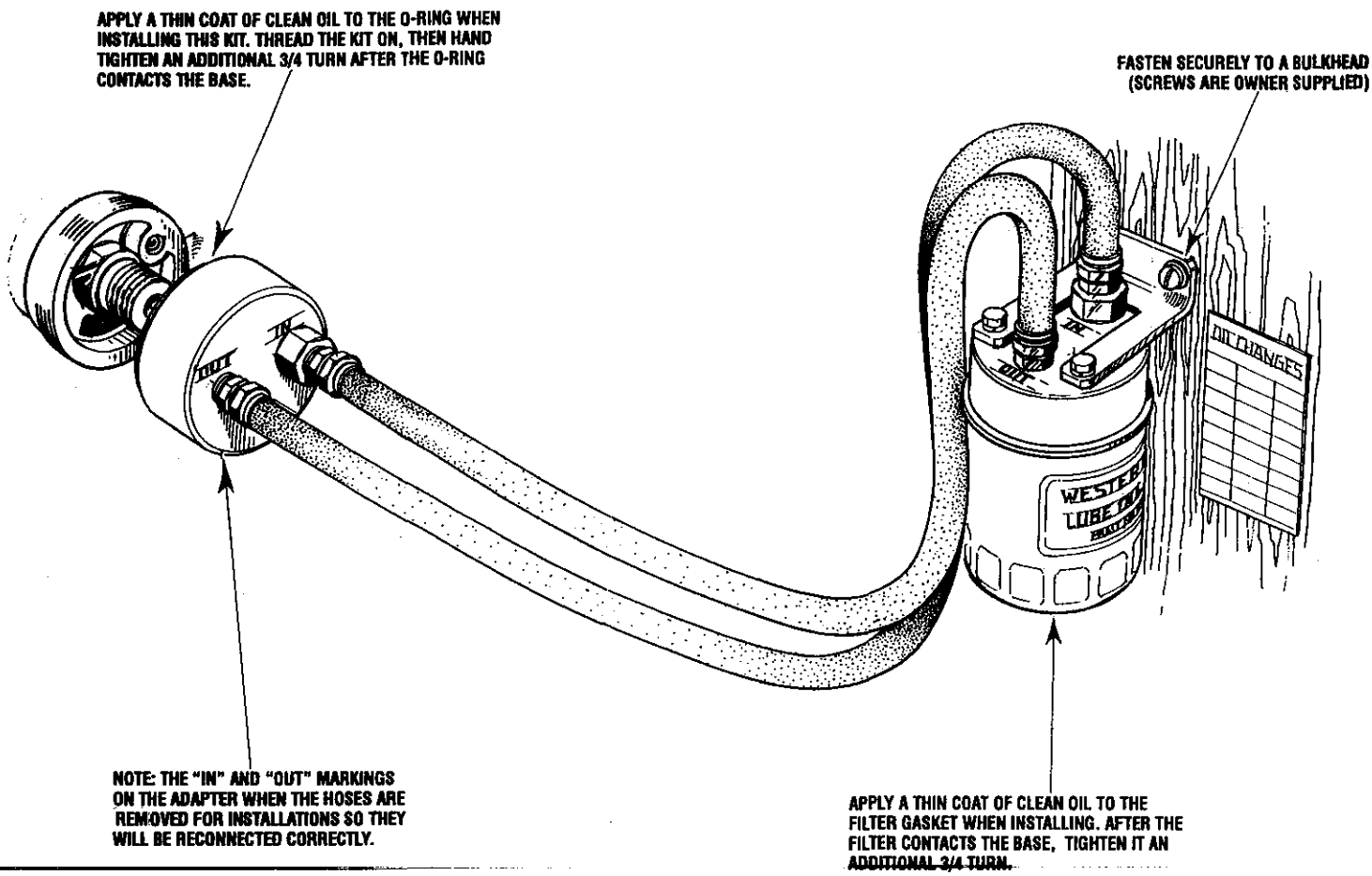
This popular accessory is used to relocate the engine's oil filter from the engine to a more convenient location such as an engine room bulkhead.

**NOTE:** *Refer to ENGINE OIL CHANGE in this manual for instructions on removing the oil filter.*

To install, simply remove the engine oil filter and thread on WESTERBEKE's remote oil filter kit as shown. Always install this kit with the oil filter facing down as illustrated.

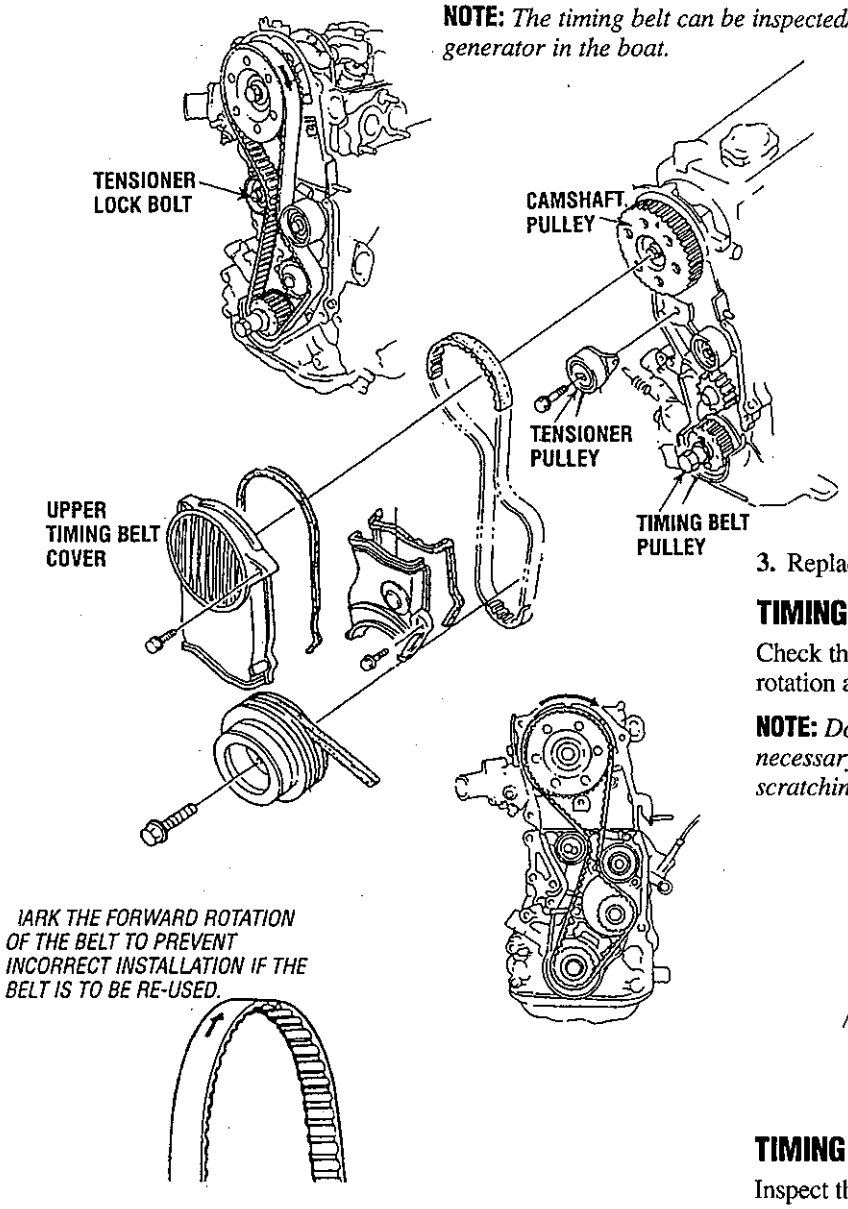
Contact your WESTERBEKE dealer for more information.

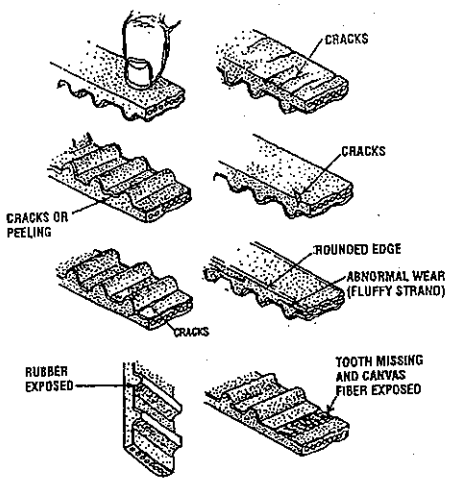
**NOTE:** *Westerbeke is not responsible for engine failure due to incorrect installation of the Remote Oil Filter.*


APPLY A THIN COAT OF CLEAN OIL TO THE O-RING WHEN INSTALLING THIS KIT. THREAD THE KIT ON, THEN HAND TIGHTEN AN ADDITIONAL 3/4 TURN AFTER THE O-RING CONTACTS THE BASE.
FASTEN SECURELY TO A BULKHEAD (SCREWS ARE OWNER SUPPLIED)
OIL CHANGES
NOTE: THE "IN" AND "OUT" MARKINGS ON THE ADAPTER WHEN THE HOSES ARE REMOVED FOR INSTALLATIONS SO THEY WILL BE RECONNECTED CORRECTLY.
APPLY A THIN COAT OF CLEAN OIL TO THE FILTER GASKET WHEN INSTALLING. AFTER THE FILTER CONTACTS THE BASE, TIGHTEN IT AN ADDITIONAL 3/4 TURN.

# TIMING BELT
# DISASSEMBLY/INSPECTION

**NOTE:** *The timing belt can be inspected/replaced with the generator in the boat.*




*MARK THE FORWARD ROTATION OF THE BELT TO PREVENT INCORRECT INSTALLATION IF THE BELT IS TO BE RE-USED.*



## DISASSEMBLY

1. Remove the tensioner spring after loosening the tensioner lock bolt.
2. Remove the timing belt.

**NOTE:** *Do not allow oil or water to contaminate the timing belt. Do not twist, turn inside out, or bend the belt.*

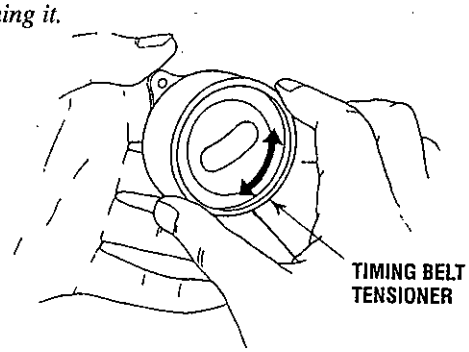
## TIMING BELT INSPECTION

1. Replace the timing belt if there is any oil, grease, or moisture on it.
2. Check for damage, wear, peeling, cracks, and hardening. Replace if necessary.
3. Replace the belt if any of the above conditions exist.

## TIMING BELT TENSIONER AND IDLER PULLEY

Check the timing belt tensioner and idler pulley for smooth rotation and abnormal noise. Replace if necessary.

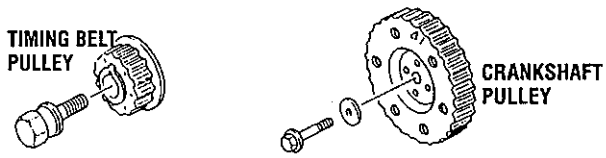
**NOTE:** *Do not clean the tensioner with cleaning fluids. If necessary, use a soft rag to wipe it clean, and avoid scratching it.*




## TIMING BELT PULLEY AND CAMSHAFT PULLEY

Inspect the pulley teeth for wear, deformation, or other damage. Replace if necessary.

**NOTE:** *Do not clean the pulley with cleaning fluids. If necessary, use a rag to wipe it clean.*

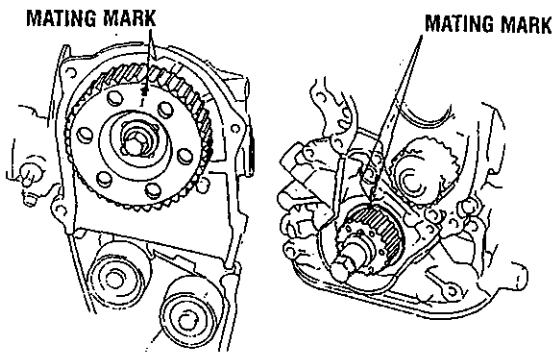



## TIMING BELT COVER (LOWER AND UPPER)

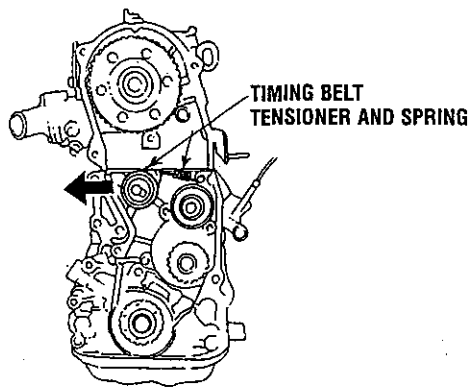
Inspect the timing belt covers for damage or cracks. Replace if necessary.

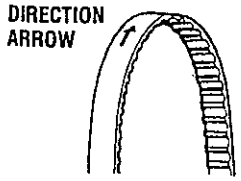
## INSTALLATION

1. Align the timing mark on the timing belt pulley and camshaft pulley with the marks.
2. Remove all the spark plugs. This is to prevent compression when rotating the timing belt.

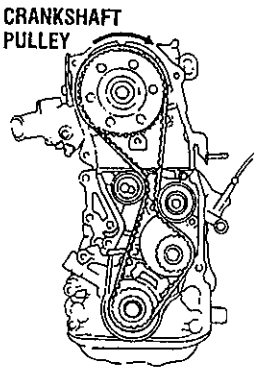



3. Install the timing belt tensioner and spring.
4. Position the timing belt tensioner all the way to the intake side, and temporarily secure it by tightening the lock bolt.

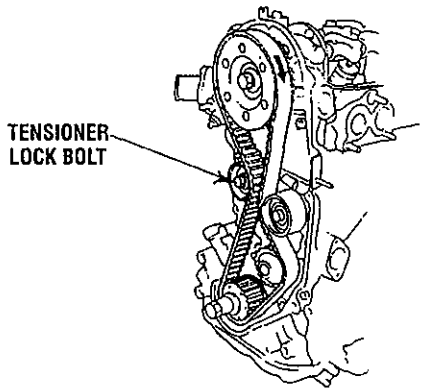



*IF RE-USING THE TIMING BELT, INSTALL IT IN THE DIRECTION OF THE APPLIED ARROW - FORWARD ROTATION.*




5. Install the timing belt on the crankshaft pulley and the camshaft pulley from the tension side (the right side as viewed from the front of the engine) so that tension is retained.
6. Loosen the tensioner lock bolt so that the tensioner spring applies tension.
7. Turn the crankshaft twice in the direction of rotation. This will apply equal tension to each side of the timing belt.




**⚠ CAUTION:** ***Water or oil on the timing belt severely reduces the service life of the belt. keep the timing belt sproket and tensioner free of oil and grease. These parts should never be cleaned. Replace if seriously contaminated with dirt or oil. If oil is evident on these parts, check the front case, oil pump seals, and camshaft oil seals for a possible leak.***

# ENGINE ADJUSTMENTS

## SPARK PLUGS

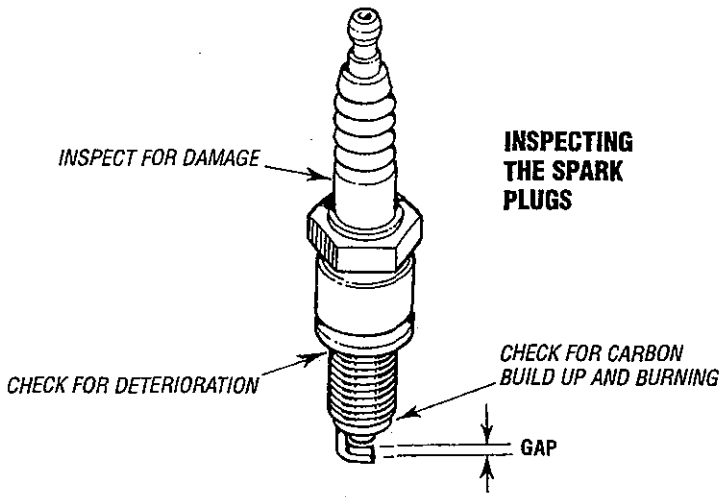
The spark plugs should be cleaned and re-gapped after the first 50 hour break-in period, then inspected every 250 hours thereafter and replaced as needed.

> ⚠ **WARNING:** ***Do not remove the spark plugs while the engine is hot. Allow the engine to cool before removing them.***

**SPARK PLUG GAP: 0.028 - 0.033in (0.7 - 0.8mm)**

**SPARK PLUG TORQUE: 11 - 15 lb-ft (1.5 - 2.31 kg-m)**

**NOTE:** *Loctite Anti-Seize applied to the threaded portion of the spark plugs will retard corrosion, making future removal of the spark plugs easier.*



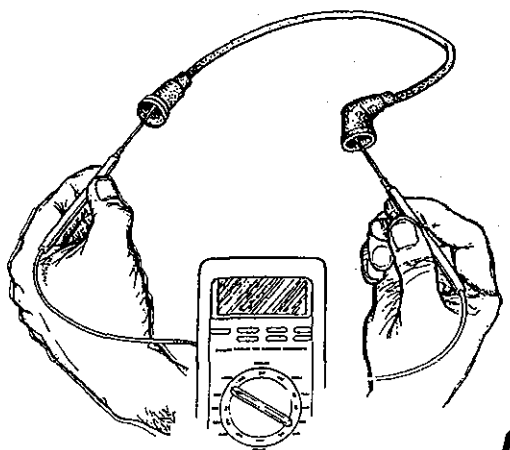

**INSPECTING THE SPARK PLUGS**

## HIGH TENSION CORDS (IGNITION WIRES)

Check the ignition wires every 500 operating hours as engine compartment heat can deteriorate the wires.

Check the resistance of each wire. Do not pull on the wire because the wire connection inside the cap may become separated or the insulator may be damaged. When removing the wires from the spark plugs, grasp and twist the moulded cap, then pull the cap off the spark plug.

**The resistance value is 410 ohm per inch of wire.**



**CHECKING RESISTANCE**

## DRIVE BELT ADJUSTMENT

The drive belts must be properly tensioned. Excessive drive belt tension can cause rapid wear of the belt and reduce the service life of the fresh water pump's bearing. A slack belt or the presence of oil on the belt can cause belt slipping, resulting in high operating temperatures.

The 22.5Kw and 20Kw SBEG generators have two drive belts, one drives the governor and alternator and the other drives the raw water pump. The tension adjustment procedure for both belts is as follows:

> ⚠ **WARNING:** ***Never attempt to check or adjust the drive belt's tension while the engine is in operation.***

1. Remove the belt guard.
2. To adjust the governor drive belt, loosen the two governor mounting bolts.

   To adjust the raw water pump/fresh water pump drive belt, loosen the two raw water pump mounting bolts.
3. With the belt(s) loose, inspect for wear, cracks, and frayed edges, and replace if necessary.
4. To loosen or tighten the governor drive belt, slide the governor in or out as required, then retighten its mounting bolts.

   To loosen or tighten the raw water pump/fresh water pump drive belt, slide the raw water pump in or out as required, then retighten its mounting bolts.
5. The drive belts are properly adjusted if it can be deflected no less than 3/8 inch (10mm) and no more than 1/2 inch (12mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt.

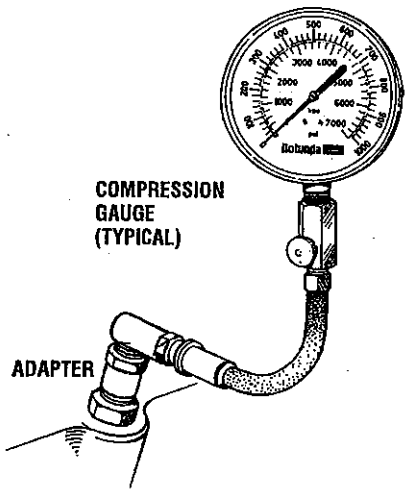
   **NOTE:** *Maintain a 22lb pressure to the belt's outer face for proper belt operation. Spare belts should always be carried on board.*
6. Operate the generator for about 5 minutes then shut down and recheck the belt(s) tension.
7. Replace the belt guard.

# ENGINE ADJUSTMENTS

**NOTE:** *WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic.*

## ENGINE COMPRESSION TEST

1. To check the engine's compression pressure, warm up the engine then shut it down.
2. Remove the three spark plug caps and remove the three spark plugs.
3. Install a compression adapter and gauge in the spark plug hole.
4. Close off the raw water intake seacock.
5. Crank the engine with the start motor and unplug the ignition coil and allow the compression gauge to reach a maximum reading and record.




6. Measure the compression pressure for all the cylinders. Ensure that compression pressure differential for each cylinder is within the specified unit.

   **Compression pressure should not differ by more than 14 psi (100 Kpa).**

7. If a cylinder's compression or pressure differential is below the limit, add a small amount of engine oil through the spark plug hole and repeat steps 4 and 5.

   (a) If additional of oil causes an increase of pressure, the piston ring and/or cylinder wall may be worn or damaged.

   (b) If additional oil does not increase compression pressure suspect poor valve contact, valve seizure, or valve wear.

8. Reinstall three plugs and ignition wires.
9. **Open the raw water thru seacock.**

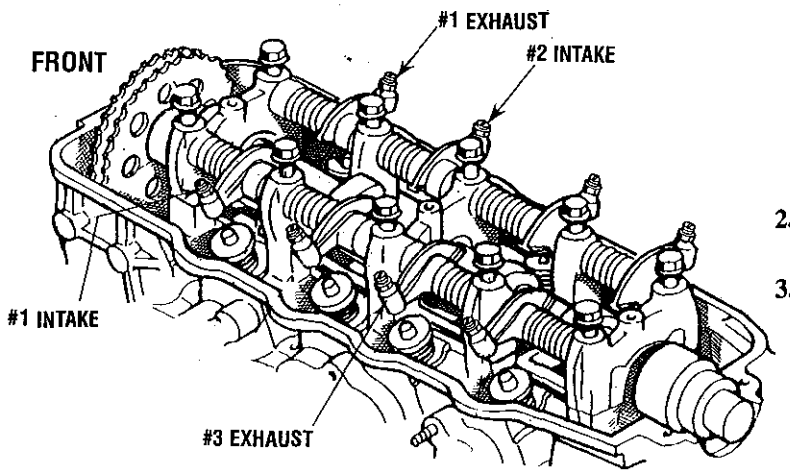
# ENGINE ADJUSTMENTS

**NOTE:** *WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic.*

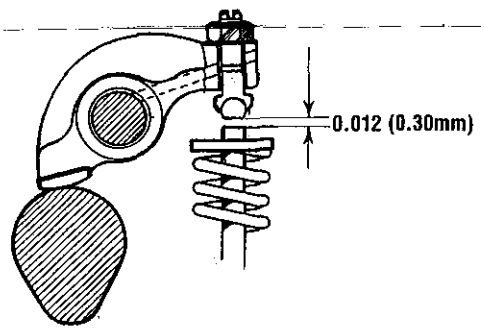
## VALVE CLEARANCE ADJUSTMENT

**NOTE:** *Retorque the cylinder head bolts before adjusting the engine's valves. See* TORQUING THE CYLINDER HEAD BOLTS.

1. Remove the rocker cover and gasket.
2. Position the No.1 piston at Top dead Center (TDC) of its compression stroke and adjust the #1 and #3 exhaust calves. While facing the front of the engine, rotate the crankshaft 360° clockwise and adjust the remaining valves.



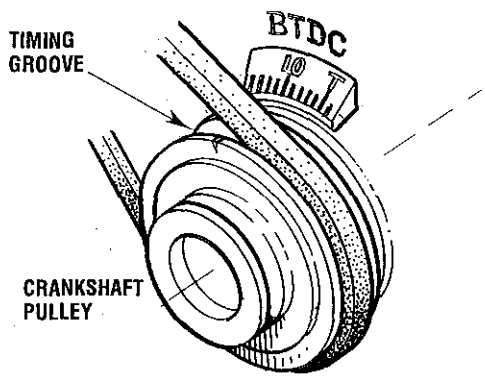

3. Replace the rocker cover and the rocker cover gasket.
   **ROCKER COVER TORQUE: 2.9 - 5.1 lb-ft (0.4 - 0.7 kg-m)**
4. Adjust all valves to 0.012 (0.30mm) with the engine hot.




## IGNITION TIMING

1. Attach a digital timing light to the #1 spark plug and mark the front crankshaft timing groove and the timing mark on the scale embossed on the engine's front cover.

   Each timing mark represents 2°.



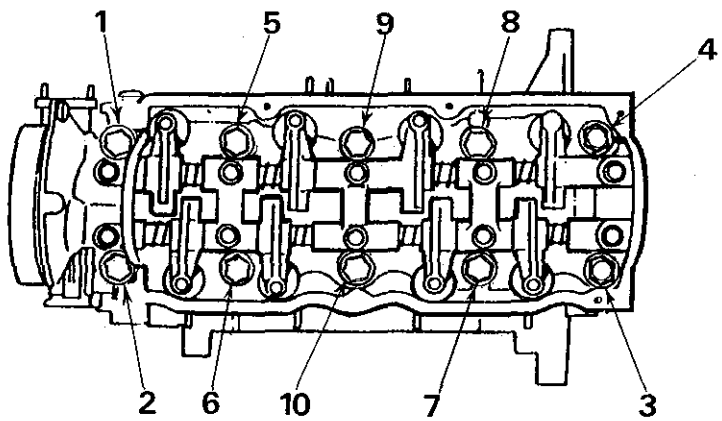

2. Start the engine and warm the engine to its normal operating temperature.
3. Using the digital timing light, check the ignition timing first with the vacuum hose disconnected from the distributor and then with it connected. Compare timing with the specifications below. Adjust the timing as needed.

   **Timing Specifications: 16° BTDC at 1800 rpm ±1°**
   **(vacuum advance hose disconnected)**
   **33° BTDC at 1800 rpm ±1°**
   **(vacuum advance hose connected)**

## TORQUING THE CYLINDER HEAD BOLTS

After the initial break-in period (approximately 50 hours), the cylinder head bolts should be re-torqued.

Tighten the cylinder head bolts according to the sequence shown. Make sure the engine is cold when this is done, and loosen one head bolt one-half turn and then tighten it between 43 - 51 lb-ft (60 - 70 Nm). Then proceed to the next head bolt in the sequence. Tighten the RS (rocker cover stud) securely.



# GENERATOR INFORMATION

## USE OF ELECTRIC MOTORS

The power required to start an electric motor is considerably more than is required to keep it running after it is started. Some motors require much more current to start them than others. Split-phase (AC) motors require more current to start, under similar circumstances, than other types. They are commonly used on easy-starting loads, such as washing machines, or where loads are applied after the motor is started, such as small power tools. Because they require 5 to 7 times as much current to start as to run, their use should be avoided, whenever possible, if the electric motor is to be driven by a small generator. Capacitor and repulsion-induction motors require from 2 to 4 times as much current to start as to run. The current required to start any motor varies with the load connected to it. An electric motor connected to an air compressor, for example, will require more current than a motor to which no load is connected.

In general, the current required to start 115-Volt motors connected to medium starting loads will be approximately as follows:

| MOTOR SIZE (HP) | AMPS FOR RUNNING (AMPERES) | AMPS FOR STARTING (AMPERES) |
|---|---|---|
| 1/6 | 3.2 | 6.4 to 22.4* |
| 1/4 | 4.6 | 9.2 to 32.2* |
| 1/3 | 5.2 | 10.4 to 72.8* |
| 1/2 | 7.2 | 14.4 to 29.2* |
| 3/4 | 10.2 | 20.4 to 40.8* |
| 1 | 13 | 26 to 52 |

***NOTE:** *In the above table the maximum* Amps for Starting *is more for some small motors than for larger ones. The reason for this is that the hardest starting types (split-phase) are not made in larger sizes.*

Because the heavy surge of current needed for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

## REQUIRED OPERATING SPEED

Run the generator first with no load applied, then at half the generators capacity, and finally loaded to its full capacity as indicted on the generators data plate. The output voltage should be checked periodically to ensure proper operation of the generating plant and the appliances it supplies. If an AC voltmeter or ampmeter is not installed to monitor voltage and load, check it with a portable meter and amp probe.

**NOTE:** *When the area in which the generator is installed contains AC equipment of 120 volts only, it is recommended that the generators AC terminal block be configured to provide one 120 volt AC hot leg for the distribution panel. This will ensure good motor starting response from the generator.*

## Generator Maintenance

- Maintaining reasonable cleanliness is important. Connections of terminal boards and rectifiers may become corroded, and insulation surfaces may start conducting if salts, dust, engine exhaust, carbon, etc. are allowed to build up. Clogged ventilation openings may cause excessive heating and reduced life of windings.
- For unusually severe conditions, thin rust-inhibiting petroleum-base coatings, should be sprayed or brushed over all surfaces to reduce rusting and corrosion.
- In addition to periodic cleaning, the generator should be inspected for tightness of all connections, evidence of overheated terminals and loose or damaged wires.
- The drive discs on single bearing generators should be checked periodically if possible for tightness of screws and for any evidence of incipient cracking failure. Discs should not be allowed to become rusty because rust may accelerate cracking. The bolts which fasten the drive disc to the generator shaft must be hardened steel SAE grade 8, identified by 6 radial marks, one at each of the 6 corners of the head.
- The rear armature bearing is lubricated and sealed; no maintenance is required. However, if the bearing becomes noisy or rough-sounding, have it replaced.
- Examine bearing at periodic intervals. No side movement of shaft should be detected when force is applied.If side motion is detectable, inspect the bearing and shaft for wear. Repair must be made quickly or major components will rub and cause major damage to generator.

## CARBON MONOXIDE DETECTOR

WESTERBEKE recommends mounting a carbon monoxide detector in the living quarters. **Carbon Monoxide, even in small amounts is deadly.**

The presence of carbon monoxide indicates an exhaust leak from the engine or generator or from the exhaust elbow/exhaust hose, or that fumes from a nearby generator are leaking in your area.

If carbon monoxide is present, ventilate the area with clean air and correct the problem immediately!

# THE SBEG GENERATOR
## SINGLE AND THREE PHASE

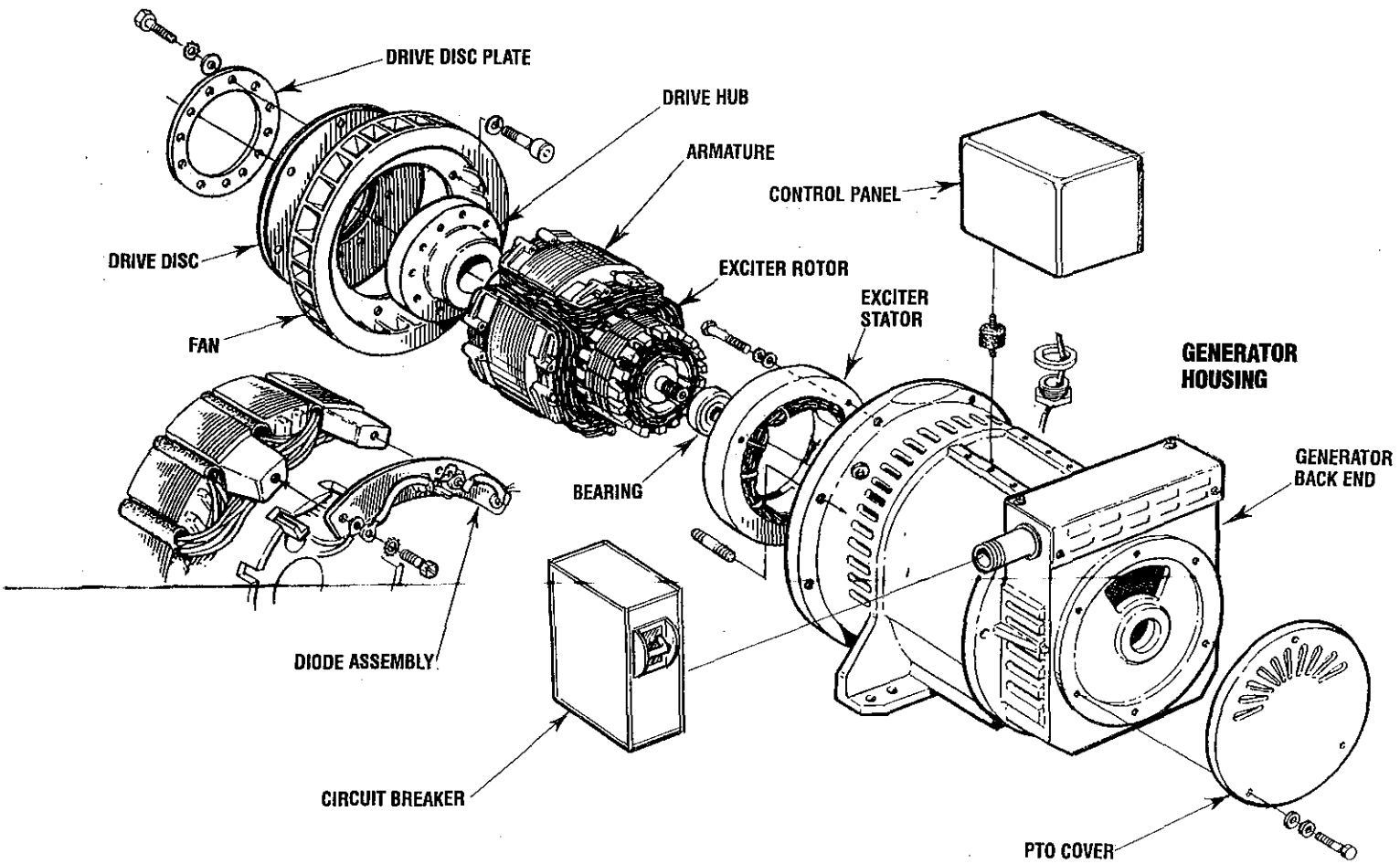
### DESCRIPTION

This generator is a four-pole, brushless, self-excited generator which requires only the driving force of the engine to produce AC output. The copper and laminated iron in the exciter stator are responsible for the self-exciting feature of this generator. The magnetic field produced causes an AC voltage to be induced into the related excitor rotor windings during rotation. Diodes located in the exciter rotor rectify this voltage to DÇ and supply it to the windings of the rotating field. This creates an electromagnetic field which rotates through the windings of the main stator, inducing an AC voltage which is supplied to a load. An AC voltage is produced in the auxiliary windings of the main stator and is, in turn, supplied to a voltage regulator. The regulator produces a DC voltage to further excite the exciter stator windings, enabling the generator to produce a rated AC output. The voltage regulator senses AC voltage output and adjusts DC excitation to the exciter stator winding according to amperage load the generator is furnishing to maintain a constant voltage output.

### CIRCUIT BREAKER

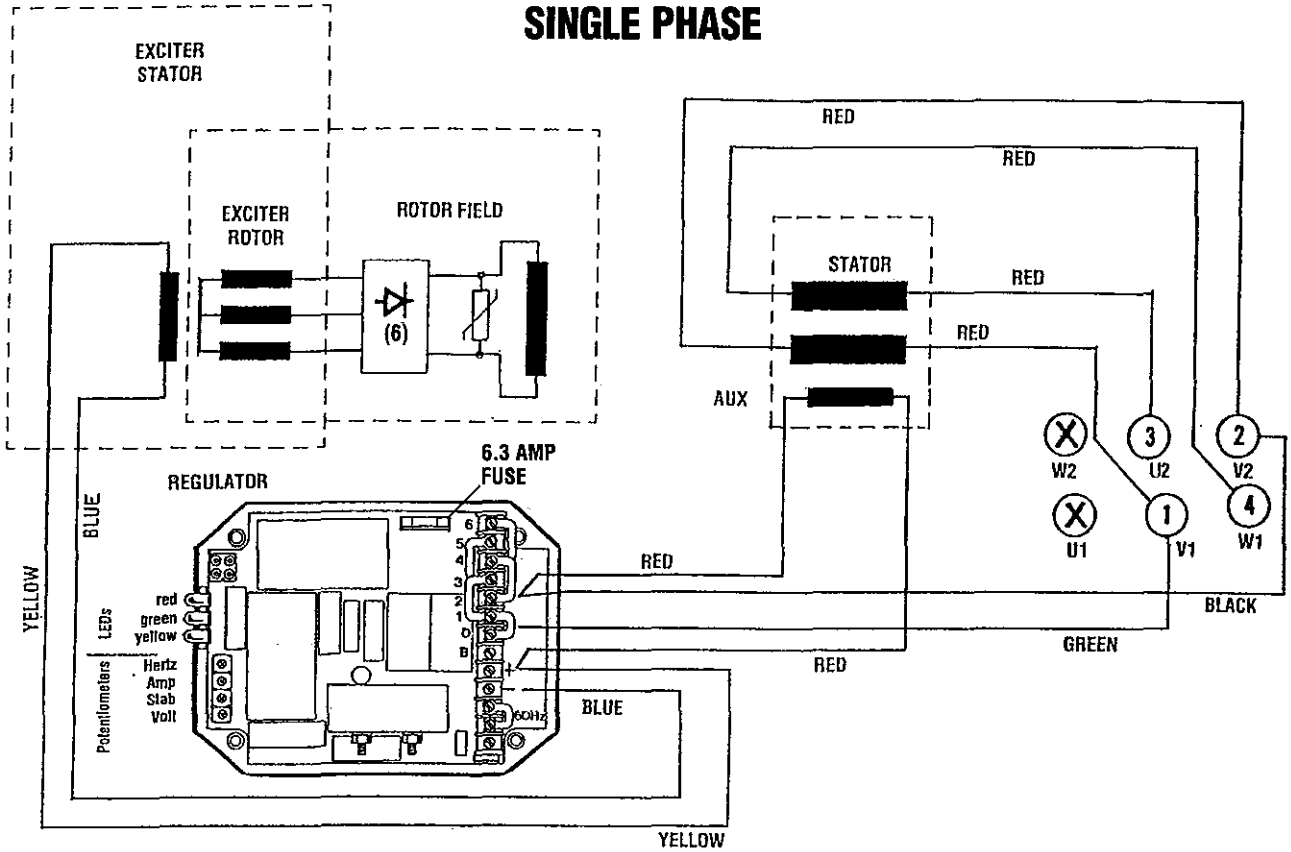
A circuit breaker is installed on all WESTERBEKE generators. This circuit breaker will automatically disconnect generator power in case of an electrical overload. The circuit breaker can be manually shut off when servicing the generator to ensure that no power is coming into the boat.

**NOTE:** *This circuit breaker is available as a WESTERBEKE add-on kit for earlier model generators; contact your WESTERBEKE dealer.*



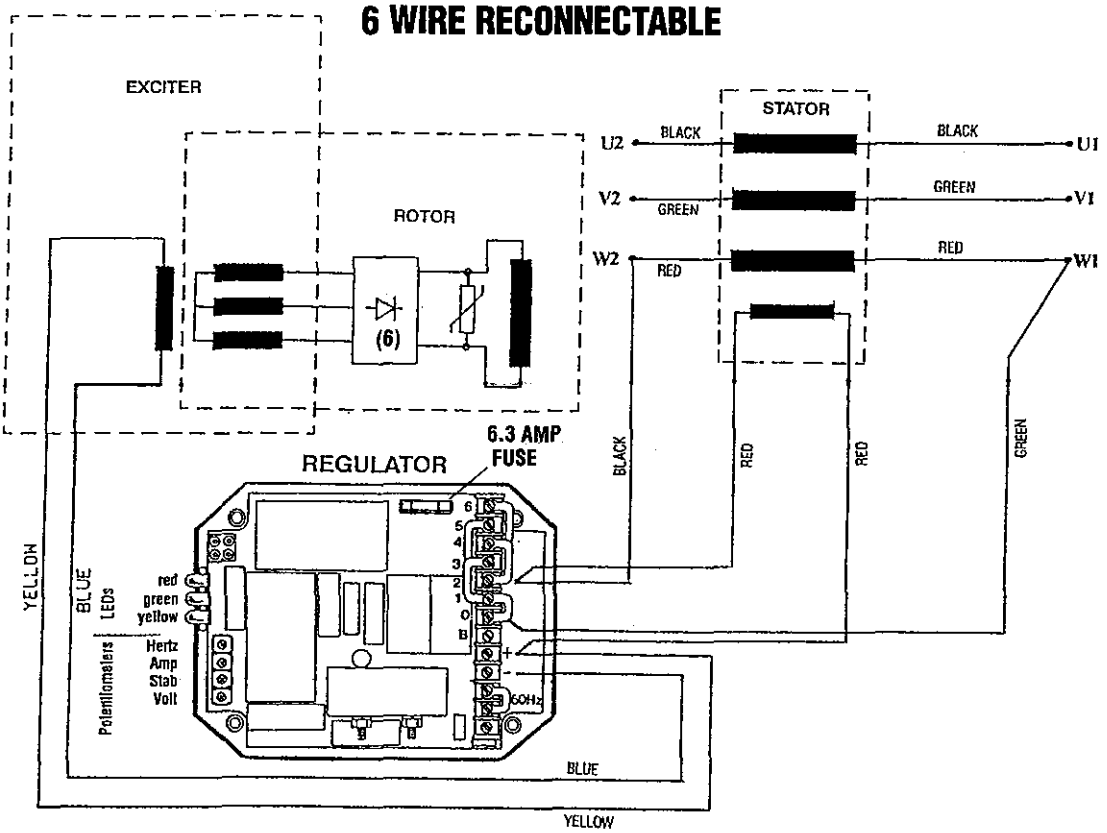
# INTERNAL WIRING SCHEMATICS

## SINGLE PHASE




## THREE PHASE

### 6 WIRE RECONNECTABLE



# GENERATOR AC VOLTAGE CONNECTIONS

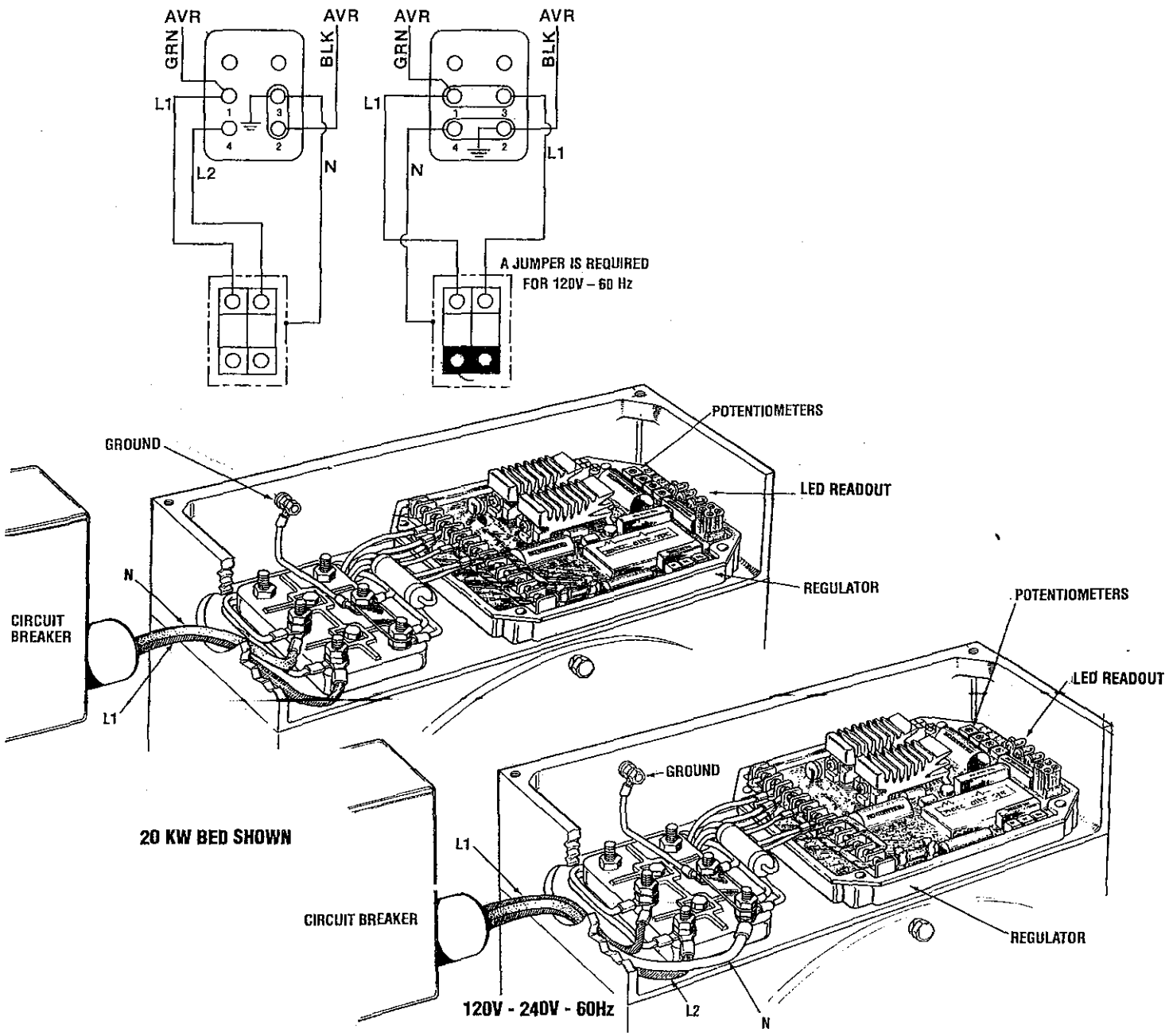
## AC VOLTAGE CONNECTIONS

**NOTE:** The frame ground wire (white/green) must be properly positioned when changing the AC output configuration of the AC terminal block. For making connections to the AC terminal block, use terminal ends for 1/4 inch studs that will accept multi strand copper wire sized for the amperage rating from the hot lead connection. The frame ground wire is white or white with a green strip. It connects between the neutral stud and the generator frame.

## Generator Frequency

Frequency is a direct result of engine/generator speed: 1800 rpm = 60 hertz; 1500 rmp = 50 hertz.

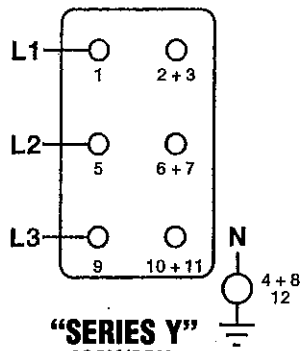
**NOTE:** *The white/green ground wire may be removed in those installations where the AC circuit has a separate neutral and ground circuit. This will prevent the unit from being a ground source in the vessel.*



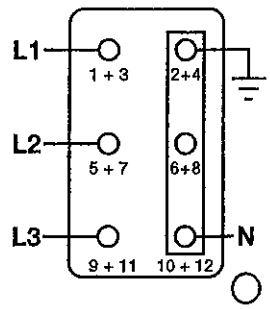
# GENERATOR AC VOLTAGE CONNECTIONS

## BE THREE PHASE 6 STUD / 12 WIRE TERMINAL BLOCKS

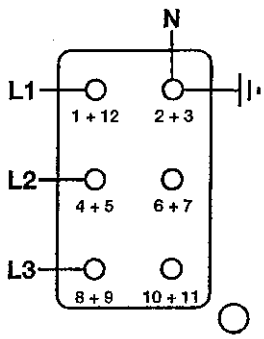
**NOTE:** *For output leads from the AC terminal block used terminal ends for 1/4" studs that accept multi-strand copper wire sized for the average rating from the hot lead connection.*



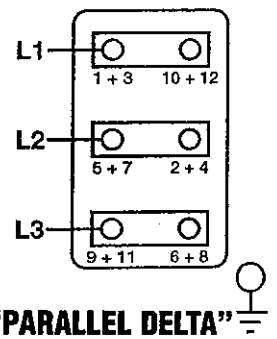

**"SERIES Y"**
**480V/60Hz**
**380V/50Hz**




**"PARALLEL Y"**
**208V/60Hz**
**190V/50Hz**

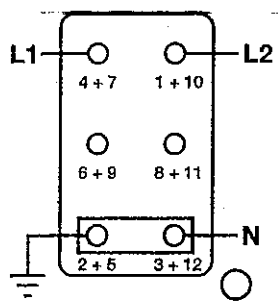



**"SERIES DELTA"**
**240V/60Hz**
**230V/50Hz**



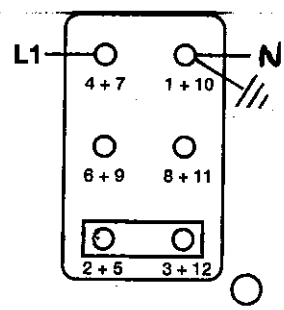

**"PARALLEL DELTA"**
**120V/60Hz**
**115V/50Hz**

**"SINGLE PHASE"**




**"DOUBLE DELTA"**
**120 - 240V/60Hz**
**115 - 230V/50Hz**
**(3 wire split single phase)**

**"SINGLE PHASE"**



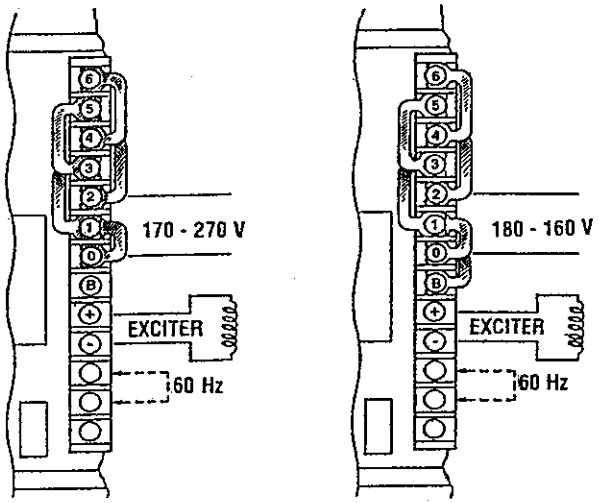

**"DOUBLE DELTA"**
**240V/60Hz**
**230V/50Hz**
**(2 wire single phase)**

# GENERATOR AC VOLTAGE CONNECTIONS

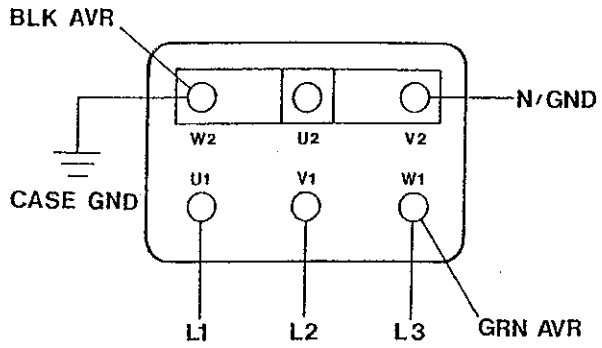
## DESCRIPTION

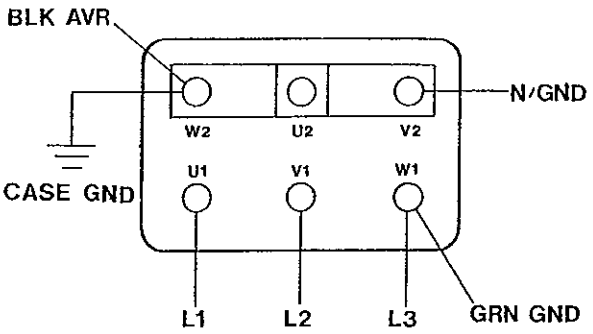
The regulator is equipped with seven numbered terminals (0 to 6) and their related brass jumpers. The illustrations show connection points and jumpers for the 3 phase configuration of the generator. The sensing leads connect between pin #1 and pin #2 on the AC terminal block and connection #2 and #0 on the voltage regulator board.

**NOTE:** *Series Delta requires the installation of a jumper on the regulator board between terminal B and 10.*



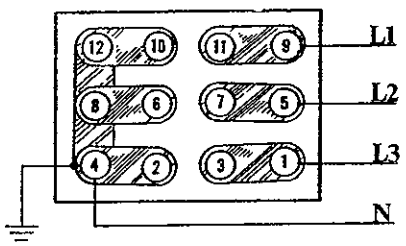

**3 PHASE VOLTAGE REGULATOR**



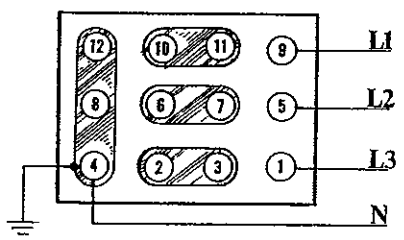

**BE THREE PHASE (SIX WIRE)**

**PARALLEL WYE (STAR)**



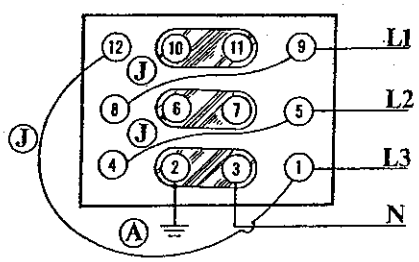

L-N – 120 VAC 1Ø 60 Hz
L-N – 110 VAC 1Ø 60 Hz

**SERIES WYE (STAR)**




L-L – 450 VAC 3Ø 60 Hz
L-N – 265 VAC 1Ø 60 Hz

**SERIES DELTA**




L-L – 240 VAC 3Ø 60 Hz
L2, L3-N – 120 VAC 1Ø 60 Hz

**BE THREE PHASE (TWELVE WIRE)**

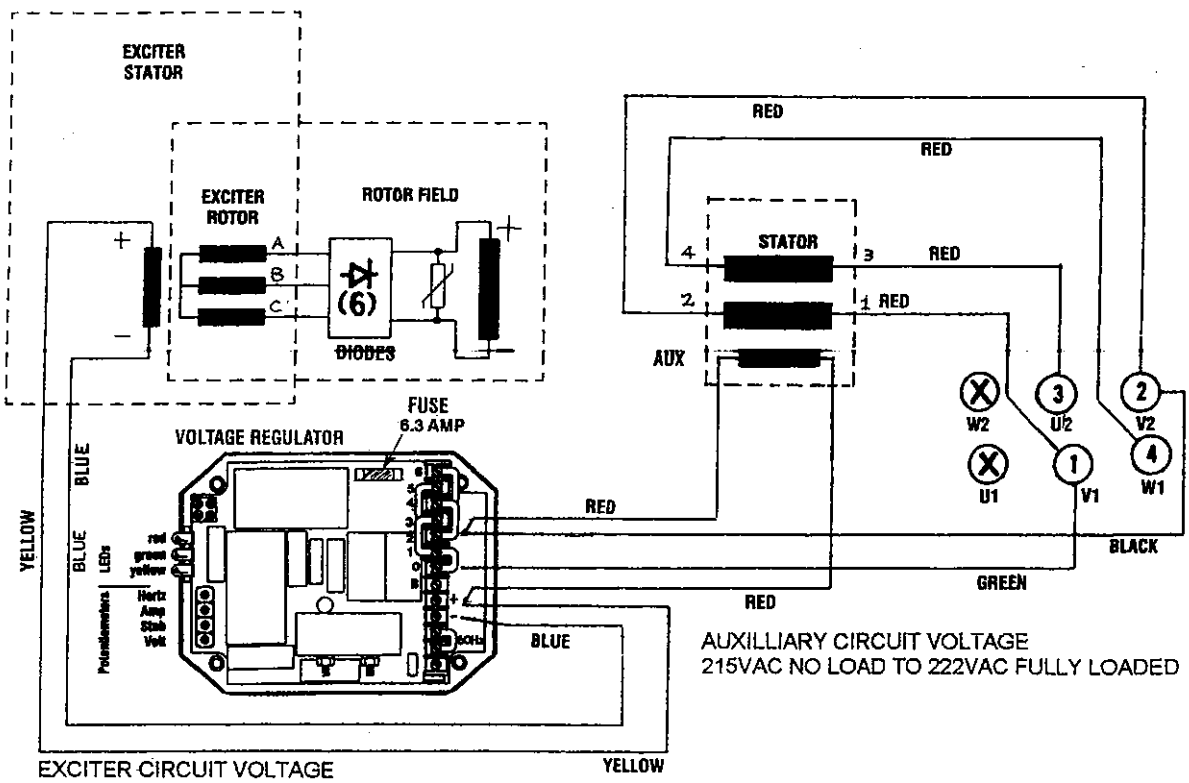
A. SERIES DELTA – Note the repositioning of the ground lead from neutral to generator housing.

J. Jumper using #10 AWG Wire.

# SBEG TROUBLESHOOTING

**NOTE:** *AC GENERATOR TROUBLESHOOTING MUST BE PERFORMED WITH THE ENGINE OPERATING AT 60 HZ.*

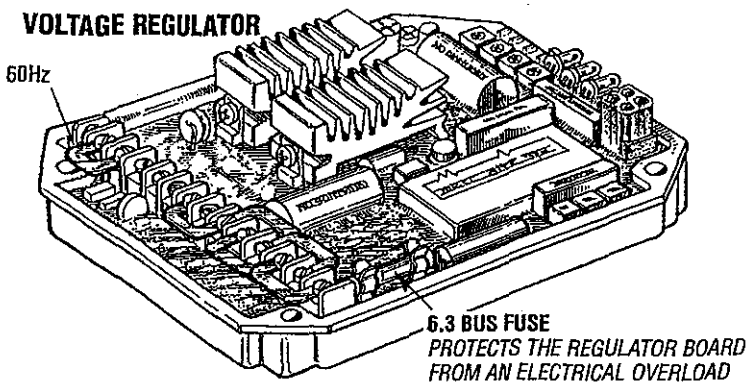
| FAULT | PROBABLE CAUSE | |
|---|---|---|
| NO AC VOLTAGE OUTPUT AT NO LOAD. | 1. Short or open in the main stator winding.<br>2. Shorted varister on exciter rotor.<br>3. Four or more shorted or open diodes on exciter rotor. | 4. Open in exciter stator winding.<br>5. Open in rotating field winding. |
| RESIDUAL VOLTAGE PRODUCED AT NO LOAD 15 - 20 VOLTS AC. | 1. Blown 6 AMP fuse auxiliary circuit feed to AVR.<br>2. Faulty voltage regulator | 3. Shorted or open main stator auxiliary winding. |
| LOW AC VOLTAGE OUTPUT AT NO LOAD 60 - 100 VAC. | 1. Reset voltage potentiometer.<br>2. Open or shorted diodes in exciter rotor 1 to 3 diodes.<br>3. Faulty voltage regulator | 4. Short in rotating field winding.<br>5. Short in exicter stator. |
| HIGH AC OUTPUT VOLTAGE 150 VAC OR HIGHER. | 1. Faulty voltage regulator. | |
| UNSTABLE VOLTAGE OUTPUT. | 1. STB pod on regulator needs adjustment. | 2. Faulty voltage regulator. |
| AC VOLTAGE DROP UNDER LOAD 60 - 100 VOLTS AC. | 1. Diode(s) on exciter rotor breaking down when load is applied (inductive) 1-3 diodes. | |



# VOLTAGE REGULATOR ADJUSTMENTS

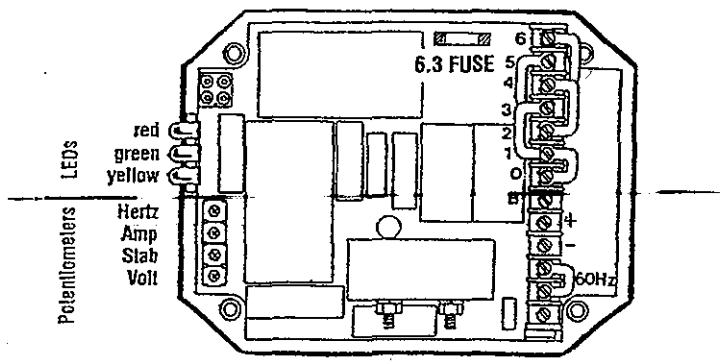
## Description

The voltage regulator is an advanced design which ensures optimum AC alternator performance. It is equipped with complete protection circuitry to guard against operating conditions that could be detrimental to the AC alternator.




## Volts

This potentiometer is used to adjust output voltage. At proper engine operating speed the output voltage should be held at ±1% from a no-load condition to a full rated generator output and from power factor 1.0 - 0.8 with engine drive speed variations up to -6%. Prior to starting the engine, turn the VOLT and STAB trimmers (using a mini phillips screw-driver) fully in a counter clockwise (Minimum) direction until you feel them hit their stops. Turn the AMP and HERTZ trimmers completely clockwise (Maximum) in the same manner. With the generator running at no-load, at normal speed, and with VOLT adjust at minimum, it is possible that output voltage will oscillate. Slowly rotate the VOLT adjust clockwise. The voltage output of the alternator will increase and stabilize. Increase the voltage to the desired value. In this situation, only the green LED will stay lit.




VOLTAGE REGULATOR DIAGRAM

## Stability

This potentiometer permits variation of the regulator's response to generator load changes so as to limit overcompensation and obtain a minimum recovery time to the normal voltage output.

In order to adjust the regulator stability the alternator must be running at no-load and the output must be monitored.

Turn the STAB adjust slowly clockwise until the voltage starts to fluctuate. At this point rotate the STAB adjust counterclockwise until the voltage is stable within 1 or 2 tenths of a volt.

## Amp-Hertz

These two adjustments are used in conjunction with the two protection circuits in the voltage regulator that are indicated by the illumination of a colored LED lights.

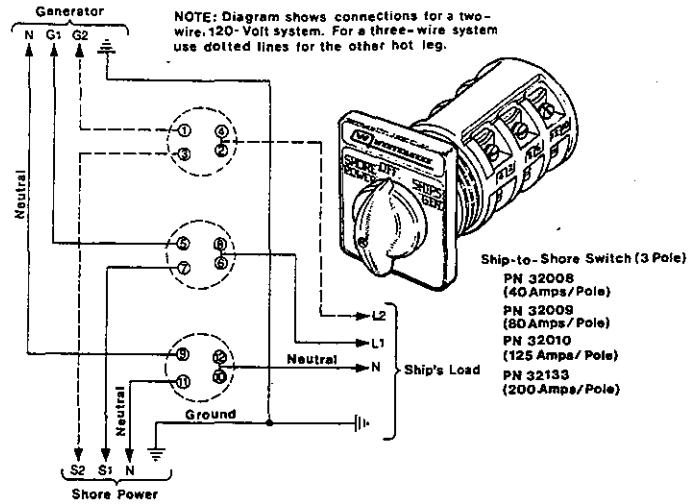
1. Delayed overload protection (yellow LED).
2. Low speed protection (red LED).

Both systems have an intervention threshold which can be adjusted using the respective potentiometer. Each of the two circuits are able to cause an adequate reduction in excitor voltage to safeguard the excitor windings and prevent their overheating.

The overload protection system has a delay which permits temporary overloading of the generator during times such as motor start-up or other similar load surge demands. The regulator also has a third LED (green), that glows during generator operation to indicate correct operation of the regulator with the generator.

# SHORE POWER TRANSFER SWITCH CONNECTIONS

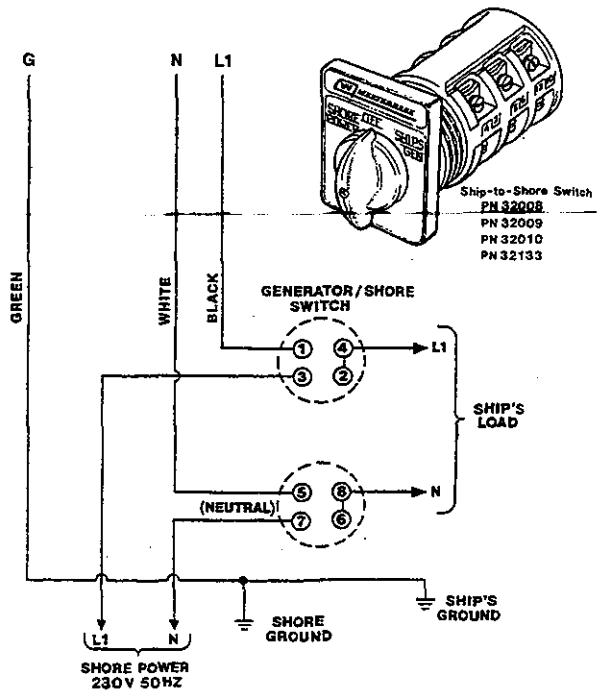
## SHORE POWER CONNECTIONS (60 HERTZ)




If the installer connects shore power to the vessel's AC circuit, this must be done by means of the Shore Power Transfer Switch. Set the transfer switch shown in the diagrams to the OFF position. This switch prevents simultaneous connection of shore power to generator output.

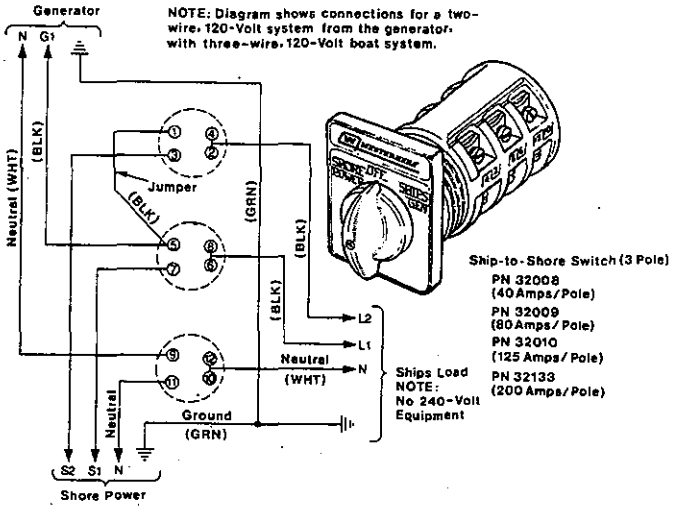
**⚠ CAUTION:** ***Damage to the generator can result if utility shore power and generator output are connected at the same time. This type of generator damage is not covered under the warranty; it is the installer's responsibility to make sure all AC connections are correct.***

## 230 VOLT/50 HERTZ TWO WIRE CONFIGURATION




## 120 VOLT/60 HZ THREE WIRE CONFIGURATION

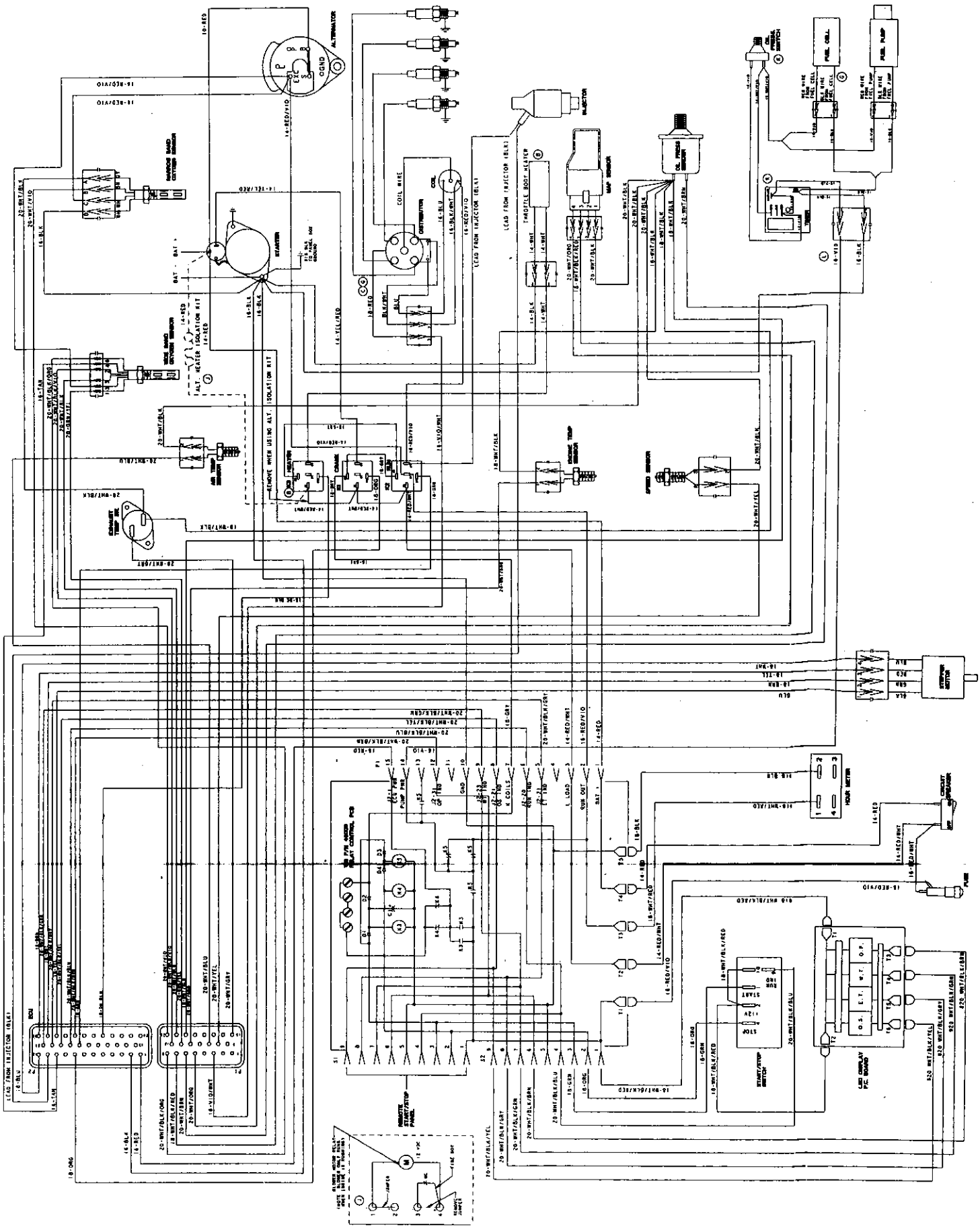
Notice the repositioning of the white wire ground load on the terminal block to the generator case.



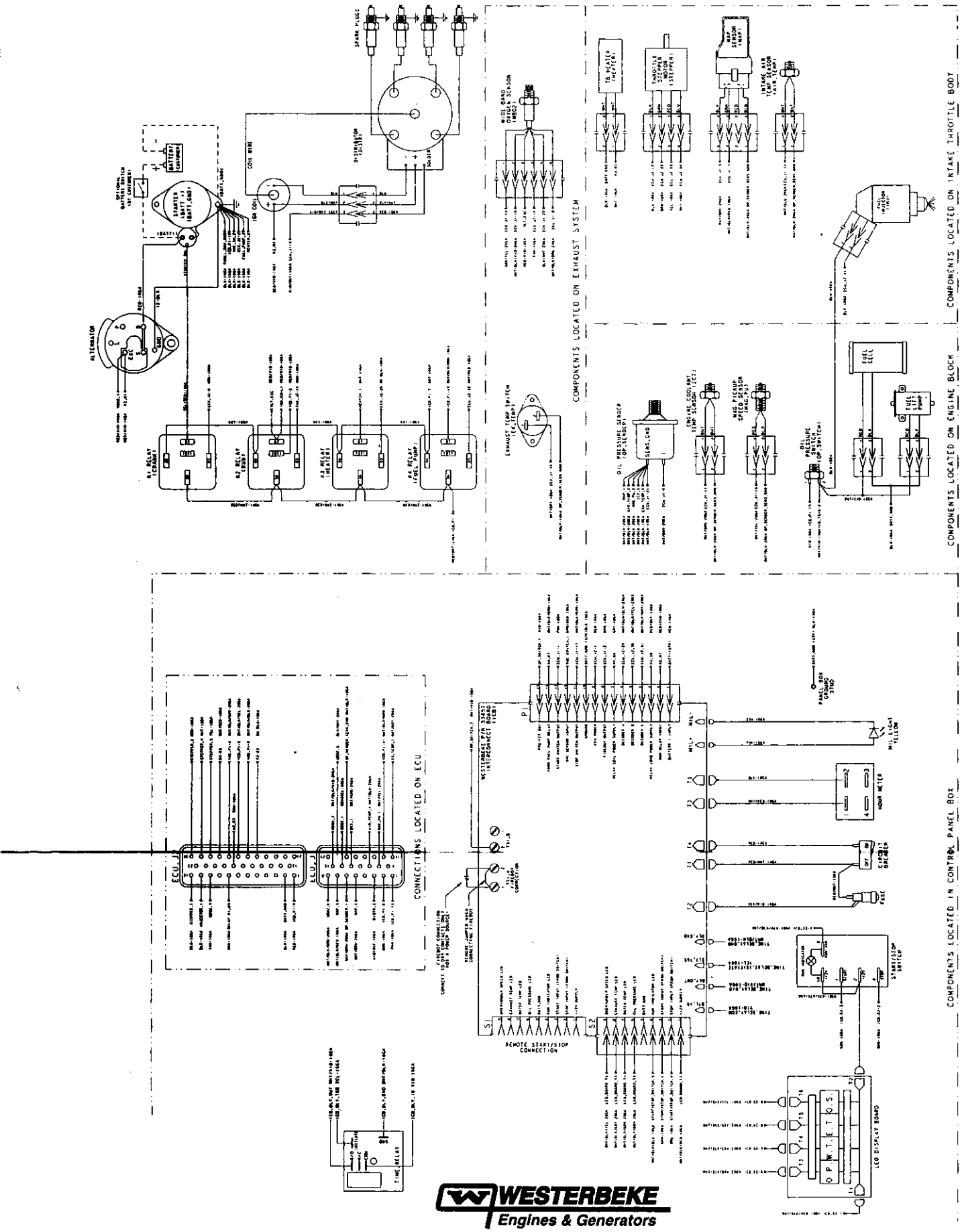

## Switching Shore Power to Generator Power

**⚠ CAUTION:** ***Heavy motor leads should be shut off before switching shore power to generator power or vice-versa because voltage surges induced by switching with heavy AC loads on the vessel being operated may cause damage to the exciter circuit components in the generator.***

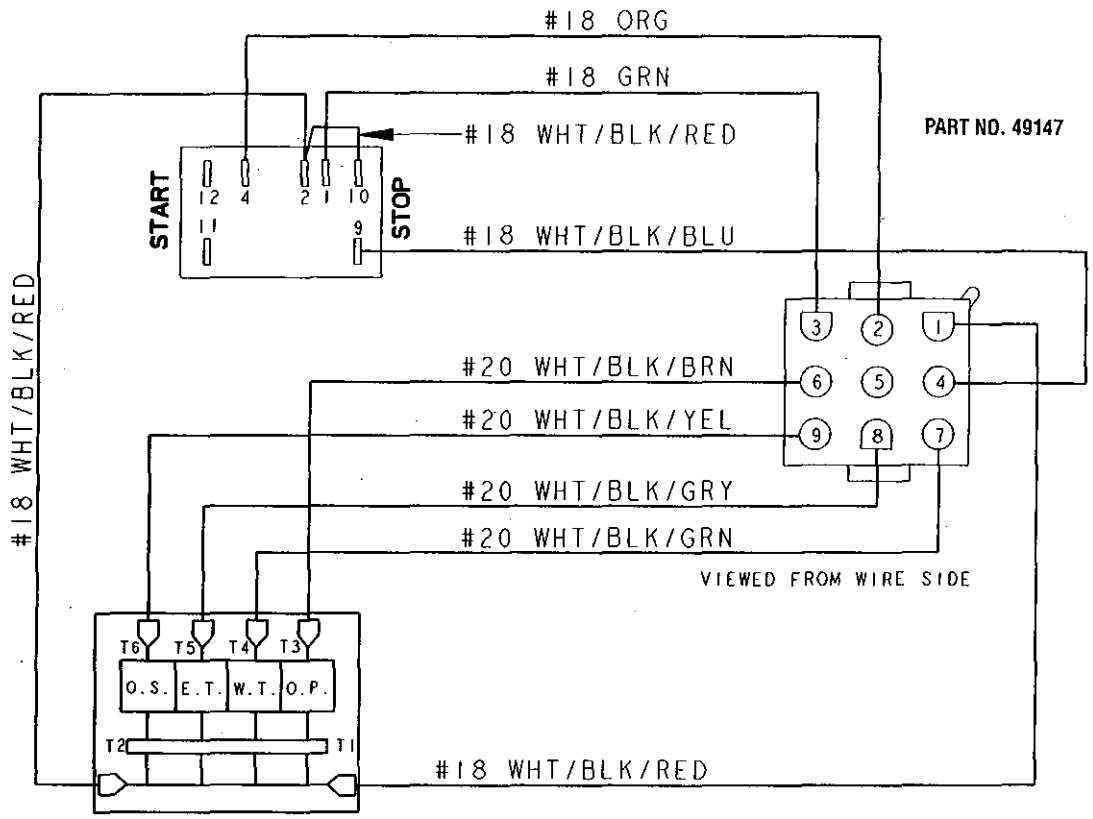
# 20KW and 22.5KW SBEG GENERATOR
## WIRING DIAGRAM #49232



# 20KW AND 22.5KW SBEGA GENERATOR
## WIRING DIAGRAM #53467



# REMOTE START/STOP PANEL WIRING
## SCHEMATIC #49209




*AVAILABLE FROM YOUR WESTERBEKE DEALER.*
*WIRING HARNESS EXTENSIONS:*

**15 FT. PART NO. 49201**
**30 FT. PART NO. 49211**
**50 FT. PART NO. 49667**
**75 FT. PART NO. 49668**
**100 FT. PART NO. 49669**

# ENGINE TROUBLESHOOTING

The following troubleshooting tables are based upon certain engine problem indicators and the most likely causes of the problems.

When troubleshooting indicates an electrical problem, see the *ELECTRICAL SYSTEM WIRING DIAGRAM* as these may reveal other possible causes of the problem which are not listed below.

**NOTE:** *The engines control system (electrical system) is protected by a 8 Ampere manual fuse located on the control panel. The generator has an AC circuit breaker at the control panel which should be in the off position when performing troubleshooting.*

**CAUTION:** When servicing or replacing DC components, turn off the 20 amp DC circuit breaker.

| PROBLEM | PROBABLE CAUSE |
|---|---|
| Engine does not crank. | 1. Voltage drop at starter solenoid terminal.<br>2. Engine circuit breaker has tripped.<br>3. 8 amp fuse/holder is faulty.<br>4. Battery is low or dead.<br>5. Loose battery connections.<br>6. Faulty wire connection.<br>7. Faulty start switch.<br>8. Faulty starter relay.<br>9. Faulty starter solenoid.<br>10. Raw water filled cylinders. |
| Engine starts, runs but then shuts down. | 1. Faulty shutdown switch. (oil pressure, coolant or exhaust temperature).<br>2. Dirty fuel/water separator filter.<br>3. Faulty speed sensor.<br>4. Low oil level in sump.<br>5. Faulty fuel pump.<br>6. High engine water or exhaust temperature.<br>7. Air in the fuel system. |
| Engine starts, runs but does not come up to speed. | 1. Faulty mag. pick-up sensor.<br>2. ECU faulty.<br>3. Fuel pump.<br>4. Fuel supply to engine restricted.<br>5. Throttle actuator binding.<br>6. Actuator or electrical connections faulty.<br>7. ~~AC generator overload./short~~.<br>8. Air intake restricted.<br>9. Exhaust restricted.<br>10. Air in fuel system. |

| PROBLEM | PROBABLE CAUSE |
|---|---|
| Engine cranks but fails to start. | 1. Out of fuel.<br>2. Engine is flooded.<br>3. Bad ignition coil.<br>4. Faulty spark plug.<br>5. Unplugged distributor wire.<br>6. Faulty electrical connection.<br>7. Air in the fuel system. |
| Engine hunts. | 1. ECU gain adjustment needed.<br>2. Faulty fuel pump.<br>3. Mag. pick-up sensor needs adjustment.<br>4. Low DC battery voltage.<br>5. Generator overload.<br>6. Valves need adjustment. |
| Engine misfires. | 1. Poor quality fuel.<br>2. Incorrect timing.<br>3. Dirty flame arrester.<br>4. Cracked distributor cap.<br>5. Faulty ignition wires.<br>6. Throttle actuator linkage binding.<br>7. High exhaust back-pressure.<br>8. Valve clearances are incorrect. |
| Engine backfires. | 1. Spark plug wires are connected wrong.<br>2. Incorrect timing.<br>3. Engine is flooded.<br>4. Dirty flame arrester.<br>5. Cracked distributor cap.<br>6. High exhaust back-pressure. |
| Engine overheats. | 1. Coolant loss. Pressure test cooling system. Refill.<br>2. Faulty raw water pump impeller.<br>3. Belts are loose or broken.<br>4. Raw water pump worn.<br>5. Faulty thermostat.<br>6. Heat exchanger restricted. |

# ENGINE TROUBLESHOOTING

| PROBLEM | PROBABLE CAUSE |
|---|---|
| Low oil pressure. | 1. Low oil level.<br>2. Wrong SAE type oil in the engine.<br>3. Faulty or wrong type oil filter.<br>4. Relief valve is stuck.<br>5. Faulty oil pump.<br>6. Faulty engine bearings.<br>7. Faulty oil filter. |
| High oil pressure. | 1. Dirty oil or wrong SAE type oil in the engine.<br>2. Relief valve is stuck. |
| No DC charge to the starting battery. | 1. Loose/corroded battery charge circuit connection(s).<br>2. Faulty alternator regulator.<br>3. Faulty DC alternator.<br>4. Slipping alternator drive belt.<br>5. Broken alternator drive belt. |

| PROBLEM | PROBABLE CAUSE |
|---|---|
| Blue exhaust smoke discharge from the engine. | 1. Lube oil is diluted.<br>2. High lube oil level.<br>3. Crankcase breather hose is clogged.<br>4. Valves are worn or adjusted incorrectly.<br>5. Piston rings are worn or unseated. |
| Black exhaust smoke discharge from the engine. | 1. Dirty flame arrester.<br>2. Lube oil is diluted.<br>3. Valves are worn or incorrectly adjusted.<br>4. Piston rings are worn or unseated.<br>5. Cankcase breather hose is clogged. |
| Poor Performance at generator speed. | 1. Fuel pump clogged. Remove and replace.<br>2. Throttle body filter screen dirty.<br>3. Fuel filter contaminated. |

### CHECK ENGINE LIGHT (YELLOW)

When the **Check Engine Light** is illuminated, the PC Interface Diagnostics will indicate the problem.

**NOTE:** *To properly troubleshoot the **Check Engine Light**, the PC Interface Diagnostics MUST be used to properly determine the fault cause.*

| PROBLEM | PROBABLE CAUSE |
|---|---|
| WideBand $O^2$ Sensor. | 1. Sensor Failure.<br>2. Sensor wiring issue. |
| Crossing Stoich. | 1. Sensor failure.<br>2. Sensor wiring issue.<br>3. Air intake obstructed. |
| $O^2$ Sensor out of range. | 1. Air intake obstructed. |

**NOTE:** *To extinguish the **Check Engine Light** once the fault is corrected. The unit must be put through three (3) consecutive successful start and stop sequences, each having a run period of approximately four (4) running minutes.*

# ELECTRICAL TROUBLESHOOTING CHART

*The following test procedures will require the use of a multimeter and the engine's wiring diagram (in this manual). Also refer to the relay testing page. WESTERBEKE recommends that these tests be performed by a qualified technician.* **CAUTION:** When servicing or replacing DC components, turn off the 20 amp DC circuit breaker.

| PROBLEM | TESTING *(12 VDC is battery + voltage measured to ground)* | INSPECTION/SOLUTION |
|---|---|---|
| Engine does not crank..... | Test for B+ (12v) at the circuit breaker to the PC board terminal T4. | Check for bad connections at the engine harness connector P1, Pin 1, the #14 red wire, or at the battery + on the starter. Check the connections at the PC board terminal 4 and at the circuit breaker |
| | **If OK ↓** | |
| | Test for B+ (12v) at the circuit breaker to the panel fuse end and to the PC board terminal T1. | Look for a bad connection from the circuit breaker to the fuse or at the PC board terminal T1. Replace the circuit breaker. |
| | **If OK ↓** | |
| | Test for B+(12v) from the fuse end to the PC board terminal T2. | Inspect the connections at the fuse or PC board terminal T2. Replace the fuse. |
| | **If OK ↓** | |
| | Test for B+(12v) at the crank relay K1 terminal 30. | Check for a bad connection at the engine harness connector P1, pin #3. Check the DC voltage at terminal #30 at the K1, K2, K3 and K4 relays. |
| | **If OK ↓** | |
| | Test for B+ (12v) at the start/stop switch terminals 2 and 10. | Look for bad connections at the panel connector S2, pin 1, white/black/red wire to the terminal PC board or at the start/stop switch terminals 2 and 10. |
| | **If OK ↓** | |
| | Test for B+ (12v) at the start switch terminal 1 when the switch is activated. | Replace the start switch. |
| | **If OK ↓** | |
| | Test for B+ (12v) at crank relay K1, terminal 86. | Check bus fuse (8 amp). |
| | **If OK ↓** | |
| | **If OK ↓** | |
| | Test for B+(12v) at crank relay K1 terminal 85. Activate the start switch and after a few seconds the voltage should drop below .5 volts. | Inspect for a bad connection at relay K1 terminal 8 orange wire or at ECU connector J2, Pin #8 |
| | **If OK ↓** | |
| | Activate the start switch, after 4-5 seconds B+(12v) should be present at terminal 87 on relay K1. | Look for a bad connection at relay K1. |
| | **If OK ↓** | |
| | Activate the start switch, after 4-5 seconds check for B+(12v) at the start solenoid. | Look for a bad connection at crank relay K1, terminal 85 orange wire or at the ECU connector J2, pin #8. |
| | **If OK ↓** | |
| | Inspect the starter. | Check the connections at crank relay K1 terminal 87, yellow/red wire or at the start solenoid. |

# ELECTRICAL TROUBLESHOOTING CHART

*The following test procedures will require the use of a multimeter and the engine's wiring diagram (in this manual). Also refer to the relay testing page. WESTERBEKE recommends that these tests be performed by a qualified technician.*

| PROBLEM | TESTING<br>*(12 VDC is battery + voltage measured to ground)* | INSPECTION/SOLUTION |
|---|---|---|
| Engine cranks but fails to start... | Test for B+ (12v) at terminals 30 and 86 on the K2 run relay<br>**If OK ↓** | Check for bad connections at both terminals. Replace the K2 relay. |
| | Test for B+ (12v) at run relay K2, terminal 85 and activate the start switch. Voltage should be less than 5 volts.<br>**If OK ↓** | Inspect the connections at relay K2, terminal 85, or at the ECU connector J2, pin 19. |
| | Activate the start switch, test for B+(12v) at relay K2 run relay, terminal 87. | Replace the K2 relay. |
| | **NOTE:** *For other possible causes (failure to start) such as fuel pump, speed sensor (MPU), ignition, etc, refer to the these sections in this manual.* | |
| Engine starts, runs but shuts down..... | Test for voltage across the oil pressure sensor terminals, with the engine running voltage should be less than 1.0 volts.<br>**If OK ↓** | Faulty oil pressure sensor. Replace sensor/switch. |
| | Test for voltage across the exhaust temperature switch, when the engine shuts down, it should read zero (0) volts.<br>**If OK ↓** | Faulty exhaust temperature switch. Replace switch.<br>Loss of coolant thru exhaust elbow.<br>High exhaust temperature. |
| | The engine temperature sensor maybe faulty. | Test sensor, refer to component testing in this manual. |
| With the PC interface, read the..... engine shutdown fault | Low DC battery charge level when cranking<br>**If OK ↓** | Change battery/ Replace battery. |
| | Speed loss<br>**If OK ↓** | Check MPU and wiring. Replace MPU. |
| | Shorted oil pressure sensor<br>**If OK ↓** | Check wiring/replace sensor |
| | External fault | Check fire suppression system for cause |

# LAY-UP & RECOMMISSIONING

## GENERAL

Many owners rely on their boatyards to prepare their craft, including engines and generators, for lay-up during the off-season or for long periods of inactivity. Others prefer to accomplish lay-up preparation themselves.

The procedures which follow will allow you to perform your own lay-up and recommissioning, or you may use them as a check list if others do the procedures.

These procedures should afford your engine protection during a lay-up and also help familiarize you with the maintenance needs of your engine.

If you have any questions regarding lay-up procedures, call your local servicing dealer; he will be more than willing to provide assistance.

## Propeller Shaft Coupling *[Propulsion Engine]*

The transmission and propeller half couplings should always be opened up and the bolts removed when the boat is hauled out of the water or moved from land to water, and during storage in the cradle. The flexibility of the boat often puts a severe strain on the propeller shaft or coupling or both, while the boat is taken out or put in the water. In some cases, the shaft has actually been bent by these strains. This does not apply to small boats that are hauled out of the water when not in use, unless they have been dry for a considerable period of time.

## Fresh Water Cooling Circuit *[Propulsion Engine]*

A 50-50 solution of antifreeze and distilled water is recommended for use in the coolant system at all times. This solution may require a higher concentration of antifreeze, depending on the area's winter climate. Check the solution to make sure the antifreeze protection is adequate.

Should more antifreeze be needed, drain an appropriate amount from the engine block and add a more concentrated mixture. Operate the engine to ensure a complete circulation and mixture of the antifreeze concentration throughout the cooling system. Now recheck the antifreeze solution's strength.

## Lubrication System

With the engine warm, drain all the engine oil from the oil sump. Remove and replace the oil filter and fill the sump with new oil. Use the correct grade of oil. Refer to the *ENGINE LUBRICATING OIL* pages in this manual for the oil changing procedure. Run the engine and check for proper oil pressure and make sure there are no leaks.

> ⚠ **CAUTION:** ***Do not leave the engine's old engine oil in the sump over the lay-up period. Lubricating oil and combustion deposits combine to produce harmful chemicals which can reduce the life of your engine's internal parts.***

## Fuel System *[Gasoline]*

Top off your fuel tanks with *unleaded* gasoline of 89 octane or higher. A fuel conditioner such as *Sta-Bil* gasoline stabilizer should be added. Change the element in your gasoline/water separator and clean the metal bowl. Re-install and make certain there are no leaks. Clean up any spilled fuel.

## Fuel System *[Diesel]*

Top off your fuel tanks with No. 2 diesel fuel. Fuel additives such as *BioBor* and *Diesel Kleen* or *Cetane Boost* should be added at this time to control algae and condition the fuel. Care should be taken that the additives used are compatible with the primary fuel filter/water separator used in the system. Change the element in your primary fuel filter/water separator, if the fuel system has one, and clean the separator sediment bowl.

Change the fuel filter elements on the engine and bleed the fuel system, as needed. Start the engine and allow it to run for 5 – 10 minutes to make sure no air is left in the fuel system. Check for any leaks that may have been created in the fuel system during this servicing, correcting them as needed. Operating the engine for 5 – 10 minutes will help allow movement of the treated fuel through the injection equipment on the engine.

## Raw Water Cooling Circuit

Close the through-hull seacock. Remove the raw water intake hose from the seacock. Place the end of this hose into a five gallon bucket of clean fresh water. Before starting the engine, check the zinc anode found in the primary heat exchanger on the engine and clean or replace it as required, and also clean any zinc debris from inside the heat exchanger where the zinc anode is located. Clean the raw water strainer.

Start the engine and allow the raw water pump to draw the fresh water through the system. When the bucket is empty, stop the engine and refill the bucket with an antifreeze solution slightly stronger than needed for winter freeze protection in your area.

Start the engine and allow all of this mixture to be drawn through the raw water system. Once the bucket is empty, stop the engine. This antifreeze mixture should protect the raw water circuit from freezing during the winter lay-up, as well as providing corrosion protection.

Remove the impeller from your raw water pump (some antifreeze mixture will accompany it, so catch it in a bucket). Examine the impeller. Acquire a replacement, if needed, and a cover gasket. Do not replace the impeller (into the pump) until recommissioning, but replace the cover and gasket.

## Intake Manifold and Thru-Hull Exhaust

Place a clean cloth, lightly soaked in lubricating oil, in the opening of the intake manifold to block the opening. Do not shove the cloth out of sight. (If it is not visible at recommissioning, and an attempt is made to start the engine, you may need assistance of the servicing dealer. Make a note to remove the cloth prior to start-up. The thru-hull exhaust port can be blocked in the same manner.

### Starter Motor

Lubrication and cleaning of the starter drive pinion is advisable, if access to the starter permits its easy removal. Make sure the battery connections are shut off before attempting to remove the starter. Take care in properly replacing any electrical connections removed from the starter.

### Cylinder Lubrication *[Diesel]*

If you anticipate a long lay-up period (12 months or more) WESTERBEKE recommends you coat the engine cylinders with SAE #40 oil. To do this, either remove the glow plug for each cylinder or the fuel injector, which ever is easiest. Squirt a good quantity of oil into each cylinder. Then rotate the engine crankshaft by hand slowly two revolutions. Re-install the glow plugs or injectors. Make sure you have available any sealing washers that may be needed for the injectors return line..

### Intake Manifold *[Gasoline]*

Clean the filter screen in the flame arrester, and place a clean cloth lightly soaked in lube oil around the flame arrester to block any opening. Also place an oil-soaked cloth in the through-hull exhaust port, Make a note to remove cloths prior to start-up!

### Cylinder Lubrication *[Gasoline]*

With the engine running, spray the fogging oil into the open intake, stalling the engine. This will lubricate the valves and cylinders..

**NOTE:** *At spring commissioning, remove and clean the spark plugs and rotate the engine by hand two complete revolutions. Re-install the spark plugs, tighten properly and reconnect the high tension leads fully onto each spark plug.*

### Batteries

If batteries are to be left on board during the lay-up period, make sure that they are fully charged, and will remain that way, to prevent them from freezing. If there is any doubt that the batteries will not remain fully charged, or that they will be subjected to severe environmental conditions, remove the batteries and store them in a warmer, more compatible environment.

> ⚠ **WARNING:** ***Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.***

### Transmission *[Propulsion Engine]*

Check or change the fluid in the transmission as required Wipe off grime and grease and touch up any unpainted areas. Protect the coupling and the output flange with an anti-corrosion coating. Check that the transmission vent is open. For additional information, refer to the *TRANSMISSION SECTION.*

### Spare Parts

Lay-up time provides a good opportunity to inspect your Westerbeke engine to see if external items such as drive belts or coolant hoses need replacement. Check your basic spares kit and order items not on hand, or replace those items used during the lay-up, such as filters and zinc anodes. Refer to the *SPARE PARTS* section of this manual.

### Recommissioning

The recommissioning of your Westerbeke engine after a seasonal lay-up generally follows the same procedures as those described in the *PREPARATIONS FOR STARTING* section regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counteracted before starting the engine.

1. Remove the oil-soaked cloths from the intake manifold.
2. Remove the raw water pump cover and gasket and discard the old gasket. Install the raw water pump impeller removed during lay-up (or a replacement, if required). Install the raw water pump cover with a new cover gasket.
3. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to make sure that the batteries are fully charged.

> ⚠ **CAUTION:** ***Wear rubber gloves, a rubber apron, and eye protection when servicing batteries. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.***

4. Remove the spark plugs, wipe clean, re-gap, and install to proper tightness *[gasoline].*
5. Check the condition of the zinc anode in the raw water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/fresh water solution from the raw water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse affects. It is advisable, as either an end of season or recommissioning service, to inspect the area where the zinc is located in the heat exchanger and clear any and all zinc debris from that area.
6. Start the engine in accordance with procedures described in the *PREPARATIONS FOR STARTING* section of this manual.

# WESTERBEKE 20KW AND 22.5KW SBEG GENERATOR SPECIFICATIONS

## ENGINE SPECIFICATIONS

| | |
|---|---|
| Engine Type | Gasoline, four-cycle, four-cylinder, fresh water-cooled, Vertical, in-line overhead mechanism |
| Governor | 1.0% speed regulation. |
| Combustion Chamber | Multi-sphere type. |
| Bore & Stroke | 3.38 x 3.70 inches (86.0 x 94.0 mm). |
| Piston Displacement | 133.26 cubic inches (2184 cubic centimeters) |
| Firing Order | 1 - 3 - 4 - 2 |
| Direction of Rotation | Clockwise, when viewed from the front |
| Compression Ratio | 8.6:1 |
| Inclination | Continuous 26°<br>Temporary 30° |
| Horsepower Output | 35hp at 1800 rpm<br>28hp at 1500 rpm |
| Weight **20Kw**<br>**22.5Kw** | 741 lbs (336 kgs)<br>771 lbs (349 kgs) |
| Fuel Consumption (at full amperage load approximate gph (lph) | **20Kw** 2.0 gph **16Kw** 6.3 lph<br>**22.5Kw** 2.2 gph **18.7Kw** 7.0 lph |

## TUNE-UP SPECIFICATIONS

| | |
|---|---|
| Compression Pressure (Limit of difference between cylinders) | 198.1 psi (14 kg/cm²) at 400 rpm<br>28.0 psi (2.0 kg/cm²) |
| Valve Timing | Intake Opens 2° BTDC<br>Intake Closes 53° ABDC<br><br>Exhaust Opens 57° BBDC<br>Exhaust Closes -2° ATDC |
| Valve Seat Angle | Intake 45°<br>Exhaust 45° |
| Valve Clearance (engine warm) | Intake 0.012 inches (0.3 mm)<br>Exhaust 0.012 inches (0.3 mm) |
| Spark Plug Gap | 0.028 - 0.033 in (0.7 - 0.8 mm) |
| Engine Timing | 16° BTDC at 1800 rpm ± .1°<br>(vacuum advance disconnected) |

## EXHAUST EMISSIONS SYSTEMS

| | |
|---|---|
| Emission Control Systems | EPA Title 40, part 1048<br>CARB Title 13, chapter 9, article 4.5 |

## IGNITION SYSTEM

| | |
|---|---|
| General | Battery ignition 12V negative ground. Distributor with ignition module and ignitor. Ignition coil and spark plugs. |
| Distributor | Solid state type with signal generator and ignitor. |
| Timing | 16° BTDC at 1800 rpm ± .1°<br>(vacuum advanced disconnection)<br><br>33° BTDC at 1800 rpm ± .1°<br>(vacuum advanced disconnection) |
| Throttle Body | Electronic fuel injector with Electronic Governor |
| Dwell | 63° at 1800 rpm. |

## FUEL SYSTEM

| | |
|---|---|
| General | Electronic Fuel Injection |
| Fuel | Regular or unleaded gasoline with an octane rating of 89 or better. |
| Fuel Lift Pump (wet) | Electric-lift capability of 6ft. (18mm) |
| Fuel Filter (on engine) | Replaceable cartridge-screw on. |
| Air Cleaner (flame arrester) | Metal screen type - cleanable. |
| Air Flow (engine combustion) | 69.5 cfm (1.9 cmm) |

## COOLING SYSTEM

| | |
|---|---|
| General | Fresh water-cooled block, thermostatically-controlled with heat exchanger. |
| Operating Temperature | 170 - 190° F (77 - 88° C) |
| Fresh Water Pump | Centrifugal type, metal impeller, belt-driven |
| Raw Water Pump | Positive displacement, rubber impeller, belt driven. |
| Raw Water Flow, at 1800 rpm | 6.7 gpm (25.3 lpm) |
| System Capacity (coolant) | 9.0 qts (8.5 liters) |

# WESTERBEKE 20KW AND 22.5KW SBEG GENERATOR SPECIFICATIONS

## LUBRICATION SYSTEM

| | |
|---|---|
| General | Pressure fed system |
| Oil Filter | Full flow, paper element, spin-on type |
| Sump Capacity (not including filter) | 4.0 U.S. qts (3.7 liters) plus filter/cooler assembly |
| Operating Oil Pressure (engine hot) | 55-75 psi (3.8 - 5.2 kg/cm²) |
| Oil Grade | API Specification of SJ, SL, or SM SAE 15W-40 |

## ELECTRICAL SYSTEM

| | |
|---|---|
| Starting Battery | 12-Volt, (-) negative ground Battery must be totally dedicated to the generator and maintained by the generators own engine DC charging alternator |
| Battery Capacity | 800 - 1000 Cold Cranking Amps(CCA) |
| Starter | 12-Volt, (-) negative ground |
| DC Charging | 12 VDC belt driven alternator. |
| DC Charging Cranking Amps | 175 - 200 amps |

## GENERATOR COOLING

| | |
|---|---|
| Air Requirements (60 Hertz at 1800 RPM) | 450 cfm (12.74 cmm) |
| Engine combustion Air Requirements (60 Hertz at 1800 RPM) | 69.5 cfm (1.9 cmm) |
| Engine Cooling Air | 200-250 cfm |
| Generator Cooling Air Requirements | 250 - 300 cfm (60 hertz - 1800 rpm) |

**NOTE:** Increase air supply 15% for 50 hertz operation (1500 rpm)

**NOTE:** Forced ventilation **must** be provided to maintain the generator compartments temperature below 104 F (40 C)

## AC GENERATOR (SINGLE PHASE)

| | | |
|---|---|---|
| General-Single Phase | Brushless six pole, revolving field. Sealed lubricated single bearing design. Reconnectable single phase for 120/240 volts with solid state voltage regulator | |
| Voltage - Single Phase | 120 Or 120/240 volts - 60 hertz | |
| Voltage Regulation | ±2% no load to full load. | |
| Frequency Regulation | 1.0 % no load to full load. | |
| Rating (Volts AC) | | |
| **20KW - 60 Hz** | 120 volts<br>120/240 volts | 166 amps<br>166/ 83 amps |
| **16KW - 50 Hz** | 230 volts | 69 amps |
| **22.5KW - 60 Hz** | 120 volts<br>120/240 volts | 187 amps<br>187/93 amps |
| **18.7KW - 50 Hz** | 230 volts | 81 amps |

## AC GENERATOR (THREE PHASE)

| | | |
|---|---|---|
| General-3 Phase | Brushless six pole, revolving field. Sealed lubricated single bearing design. 12 lead reconnectable for low voltage WYE and for Delta. Solid state voltage regulator with protection circuitry. | |
| Voltage - 3 Phase (60 Hertz) | Low voltage WYE<br>High voltage WYE<br>Delta | 208 volts<br>480 volts<br>240 volts |
| Voltage - 3 Phase (50 Hertz) | Low voltage WYE<br>High voltage WYE<br>Delta | 200 volts<br>400 volts<br>230 volts |
| **20KW - 60 Hz** Amperage 3 Phase | Low voltage WYE<br>High voltage WYE<br>Delta | 70 amps<br>35 amps<br>60 amps |
| **16KW - 50 Hz** Amperage 3 Phase | Low voltage WYE<br>High voltage WYE<br>Delta | 27.8 amps<br>28.9 amps<br>50.2 amps |
| **22.5KW - 60 Hz** Amperage 3 Phase | Low voltage WYE<br>High voltage WYE<br>Delta | 86.7 amps<br>37.6 amps<br>75.2 amps |
| **18.7KW - 50 Hz** Amperage 3 Phase | Low voltage WYE<br>High voltage WYE<br>Delta | 67.5 amps<br>33.7 amps<br>58.7amps |

# TORQUE SPECIFICATIONS - 20KW AND 22.5KW SBEG GENERATORS

| COMPONENT | FT-LB (M-KG) |
|---|---|
| Air Cleaner Bracket | 12.7 - 17.4 (1.9 - 2.6) |
| Alternator bracket | 25.5 - 35.6 (3.8 - 5.3) |
| Alternator Flange Bolt | 12.7 - 20.8 (1.9 - 3.1) |
| Alternator Strap | 12.7 - 17.4 (1.9 - 2.6) |
| Camshaft Pully Lock Bolt | 32.2 - 44.3 (4.8 - 6.6) |
| Throttle Body | 8.0 - 11.4 (1.2 - 1.7) |
| Connecting Rod Cap | 44.3 - 47.0 (6.6 - 7.0) |
| Coolant Pump | 12 - 17 (1.6 - 2.4) |
| Coolant Pump Pulley | 12 -17 (1.6 - 2.4) |
| Coolant Temperature Sendor | 9 - 13 (1.2 - 1.8) |
| Crank Shaft Pulley | 22.1 - 25.5 (3.3 - 3.8) |
| Cylinder Head | |
| Cold | 55 - 59 (8.2 - 8.8) |
| Hot | 63 - 67 (9.5 - 10.0) |
| Cylinder Head Cover | 2.6 - 4.0 (4.0 - 6.0) |
| Drive Plate | 16.1 - 18.1 (2.4 - 2.7) |
| Exhaust Manifold | 12 - 17 (1.6 - 2.4) |
| Front Housing Assembly | 12.7 - 17.4 (1.9 - 2.6) |
| Intake Manifold | 12 - 17 (1.6 - 2.4) |

| COMPONENT | FT-LB (M-KG) |
|---|---|
| Main Bearing Cap | 56.4 - 60.4 (8.4 - 9.0) |
| Oil Pan | 4.7 - 8.0 (7.0 - 12.0) |
| Oil Pressure Sender | 9 - 13 (1.2 - 1.8) |
| Oil Pump | |
| M6 | 12.7 - 17.4 (1.9 - 2.6) |
| M8 | 25.5 - 35.6 (3.8 - 5.3) |
| Oil Strainer | |
| M6 | 5.3 - 8.0 (8.0 - 12.0) |
| M8 | 10.7 - 15.4 (1.6 - 2.3) |
| Rear Cover Assembly | 5.3 - 8.0 (8.0 - 12.0) |
| Rocker Shaft Assembly | 12.0 - 18.1 (1.8 - 2.7) |
| Spark Plug | 10.0 - 15.4 (1.5 - 2.3) |
| Timing Belt Crank Pulley Bolt | 120.9 - 134.4 018.0 - 20.0) |
| Timing Belt Cover | |
| Upper | 4.7 - 6.7 (7.0 - 10.0) |
| Lower | 4.7 - 6.7 (7.0 - 10.0) |
| Timing Tension Lock Bolt | 25.5 - 35.6 (3.8 - 5.3) |
| Thermostat Cover | 12.7 - 20.8 (1.9 - 3.1) |
| Water Pump | 12.7 - 17.4 91.9 - 2.6) |

**NOTE:** *Formula to convert ft-lbs to Nm (Newton Meters) multiply ft-lb x 1.356*

# STANDARD AND METRIC CONVERSION DATA

## LENGTH-DISTANCE

Inches (in) x 25.4 = Millimeters (mm) x .0394 = Inches
Feet (ft) x .305 = Meters (m) x 3.281 = Feet
Miles x 1.609 = Kilometers (km) x .0621 = Miles

## DISTANCE EQUIVALENTS

1 Degree of Latitude = 60 Nm = 111.120 km
1 Minute of Latitude = 1 Nm = 1.862 km

## VOLUME

Cubic Inches ($in^3$) x 16.387 = Cubic Centimeters x .061 = $in^3$
Imperial Pints (IMP pt) x .568 = Liters (L) x 1.76 = IMP pt
Imperial Quarts (IMP qt) x 1.137 = Liters (L) x.88 = IMP qt
Imperial Gallons (IMP gal) x 4.546 = Liters (L) x .22 = IMP gal
Imperial Quarts (IMP qt) x 1.201 = US Quarts (US qt) x .833 = IMP qt
Imperial Gallons (IMP gal) x 1.201 = US Gallons (US gal) x .833 = IMP gal
Fluid Ounces x 29.573 = Milliliters x .034 = Ounces
US Pints (US pt) x .473 = Liters(L) x 2.113 = Pints
US Quarts (US qt) x .946 = Liters (L) x 1.057 = Quarts
US Gallons (US gal) x 3.785 = Liters (L) x .264 = Gallons

## MASS-WEIGHT

Ounces (oz) x 28.35 = Grams (g) x .035 = Ounces
Pounds (lb) x .454 = Kilograms (kg) x 2.205 = Pounds

## PRESSURE

Pounds Per Sq In (psi) x 6.895 = Kilopascals (kPa) x .145 = psi
Inches of Mercury (Hg) x .4912 = psi x 2.036 = Hg
Inches of Mercury (Hg) x 3.377 = Kilopascals (kPa) x .2961 = Hg
Inches of Water ($H_2O$) x .07355 = Inches of Mercury x 13.783 = $H_2O$
Inches of Water ($H_2O$) x .03613 = psi x 27.684 = $H_2O$
Inches of Water ($H_2O$) x .248 = Kilopascals (kPa) x 4.026 = $H_2O$

## TORQUE

Pounds-Force Inches (in-lb) x .113 = Newton Meters (Nm) x 8.85 =in-lb
Pounds-Force Feet (ft-lb) x 1.356 = Newton Meters (Nm) x .738 = ft-lb

## VELOCITY

Miles Per Hour (MPH) x 1.609 = Kilometers Per Hour (KPH) x .621 = MPH

## POWER

Horsepower (Hp) x .745 = Kilowatts (Kw) x 1.34 = MPH

## FUEL CONSUMPTION

Miles Per Hour IMP (MPG) x .354 = Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L) x 2.352 = IMP MPG
Miles Per Gallons US (MPG) x .425 = Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L) x 2.352 = US MPG

## TEMPERATURE

Degree Fahrenheit (°F) = (°C X 1.8) + 32
Degree Celsius (°C) = (°F - 32) x .56

## LIQUID WEIGHTS

Diesel Oil = 1 US gallon = 7.13 lbs
Fresh Water = 1 US gallon = 8.33 lbs
Gasoline = 1 US gallon = 6.1 lbs
Salt Water = 1 US gallon = 8.56 lbs

# METRIC CONVERSIONS

## INCHES TO MILLIMETERS / MILLIMETERS TO INCHES

| Inches | mm | Inches | mm | mm | Inches | mm | Inches |
|---|---|---|---|---|---|---|---|
| 1 | 25.40 | 15 | 381.00 | 1 | 0.0394 | 15 | 0.5906 |
| 2 | 50.80 | 20 | 508.00 | 2 | 0.0787 | 20 | 0.7874 |
| 3 | 76.20 | 25 | 635.00 | 3 | 0.1181 | 25 | 0.9843 |
| 4 | 101.60 | 30 | 762.00 | 4 | 0.1575 | 30 | 1.1811 |
| 5 | 127.00 | 35 | 889.00 | 5 | 0.1969 | 35 | 1.3780 |
| 10 | 254.00 | 40 | 1016.00 | 10 | 03937 | 40 | 1.5748 |

10 MILLIMETERS = 1CENTIMETER, 100 CENTIMETERS = 1 METER = 39.37 INCHES (3.3 FEET)

## INCHES TO METERS / METERS TO INCHES

| Inches | Meters | Inches | Meters | Meters | Inches | Meters | Inches |
|---|---|---|---|---|---|---|---|
| 1 | 0.0254 | 7 | 0.1778 | 0.1 | 3.937 | 0.7 | 27.559 |
| 2 | 0.0508 | 8 | 0.2032 | 0.2 | 7.874 | 0.8 | 31.496 |
| 3 | 0.0762 | 9 | 0.2286 | 0.3 | 11.811 | 0.9 | 35.433 |
| 4 | 0.1016 | 10 | 0.2540 | 0.4 | 15.748 | 1.0 | 39.370 |
| 5 | 0.1270 | 11 | 0.2794 | 0.5 | 19.685 | 1.1 | 43.307 |
| 6 | 0.1524 | 12 | 0.3048 | 0.6 | 23.622 | 1.2 | 47.244 |

TO CONVERT METERS TO CENTIMETERS, MOVE DECIMAL POINT TWO PLACES TO THE RIGHT

## YARDS TO METERS / METERS TO YARDS

| Yards | Meters | Yards | Meters | Meters | Yards | Meters | Yards |
|---|---|---|---|---|---|---|---|
| 1 | 0.91440 | 6 | 5.48640 | 1 | 1.09361 | 6 | 6.56168 |
| 2 | 1.82880 | 7 | 6.40080 | 2 | 2.18723 | 7 | 7.65529 |
| 3 | 2.74320 | 8 | 7.31520 | 3 | 3.28084 | 8 | 8.74891 |
| 4 | 3.65760 | 9 | 8.22960 | 4 | 4.37445 | 9 | 9.84252 |
| 5 | 4.57200 | 10 | 9.14400 | 5 | 5.46807 | 10 | 10.93614 |

MOVE DECIMAL POINT FOR HIGHER VALUES — e.g. 6,000 METERS = 6,561.68 YARDS

## POUNDS TO KILOGRAMS / KILOGRAMS TO POUNDS

| lb | kg | lb | kg | kg | lb | kg | lb |
|---|---|---|---|---|---|---|---|
| 1 | 0.454 | 6 | 2.722 | 1 | 2.205 | 6 | 13.228 |
| 2 | 0.907 | 7 | 3.175 | 2 | 4.409 | 7 | 15.432 |
| 3 | 1.361 | 8 | 3.629 | 3 | 6.614 | 8 | 17.637 |
| 4 | 1.814 | 9 | 4.082 | 4 | 8.818 | 9 | 19.842 |
| 5 | 2.268 | 10 | 4.536 | 5 | 11.023 | 10 | 22.046 |

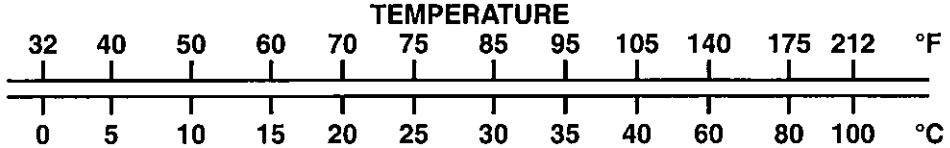
## GALLONS TO LITERS / LITERS TO GALLONS

| Gallons | Liters | Gallons | Liters | Liters | Gallons | Liters | Gallons |
|---|---|---|---|---|---|---|---|
| 1 | 3.79 | 10 | 37.86 | 1 | 0.26 | 60 | 15.66 |
| 2 | 7.57 | 20 | 75.71 | 2 | 0.53 | 90 | 23.77 |
| 3 | 11.36 | 30 | 113.57 | 5 | 1.32 | 120 | 31.32 |
| ~~4~~ | ~~15.14~~ | ~~40~~ | ~~151.42~~ | ~~10~~ | ~~2.64~~ | ~~150~~ | ~~39.62~~ |
| 5 | 18.93 | 50 | 189.28 | 20 | 5.28 | 180 | 47.54 |

## PINTS TO LITERS / LITERS TO PINTS

| Pints | Liters | Pints | Liters | Liters | Pints | Liters | Pints |
|---|---|---|---|---|---|---|---|
| 1 | 0.47 | 6 | 2.84 | 1 | 2.11 | 6 | 12.68 |
| 2 | 0.95 | 7 | 3.31 | 2 | 4.23 | 7 | 14.79 |
| 3 | 1.42 | 8 | 3.79 | 3 | 6.34 | 8 | 16.91 |
| 4 | 1.89 | 9 | 4.26 | 4 | 8.45 | 9 | 19.02 |
| 5 | 2.37 | 10 | 4.73 | 5 | 10.57 | 10 | 21.13 |

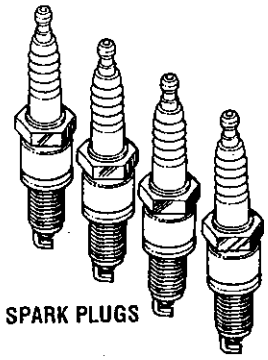
## TEMPERATURE



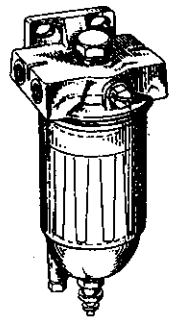
# SUGGESTED SPARE PARTS

## WESTERBEKE MARINE GENERATORS

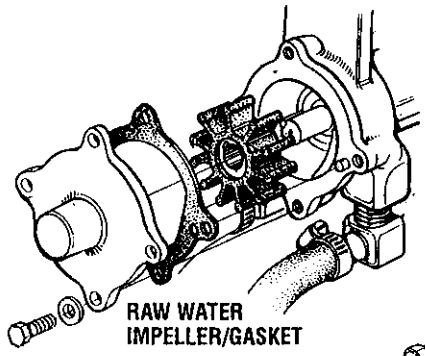
*CONTACT YOUR WESTERBEKE DEALER FOR SUGGESTIONS AND ADDITIONAL INFORMATION*



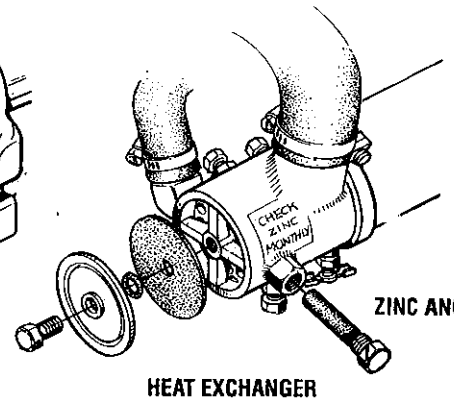
SPARK PLUGS



FUEL/WATER SEPARATOR FILTER ELEMENT

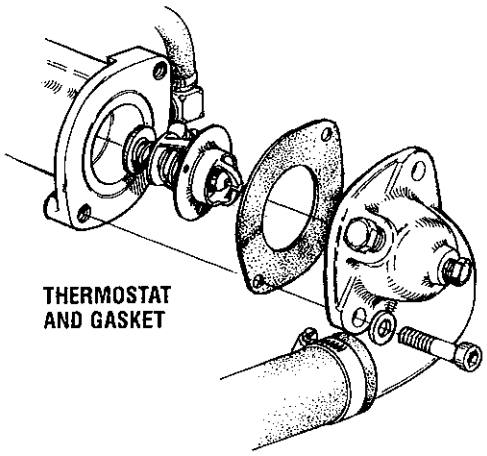


RAW WATER IMPELLER/GASKET

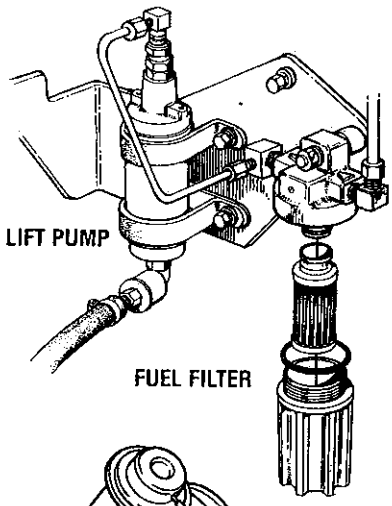



ZINC ANODES

HEAT EXCHANGER END GASKET

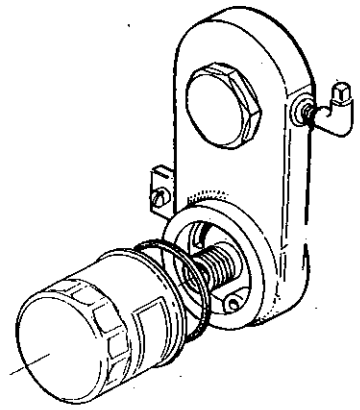


THERMOSTAT AND GASKET

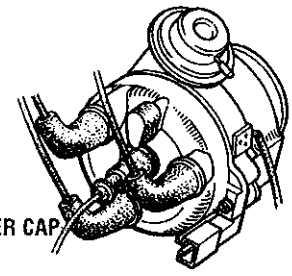


FUEL LIFT PUMP

FUEL FILTER



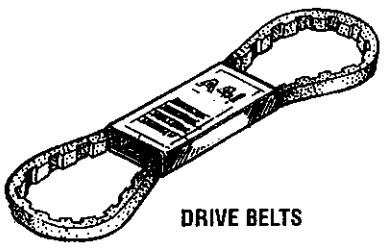
OIL FILTER



DISTRIBUTER CAP AND WIRES

SPARE FUSES

CONTROL PANEL AND BE REGULATOR



DRIVE BELTS

*WESTERBEKE RECOMMENDS CARRYING ENOUGH SPARE ENGINE OIL (YOUR BRAND) FOR AN OIL CHANGE (5 QTS.) AND A GALLON OF PREMIXED COOLANT.*

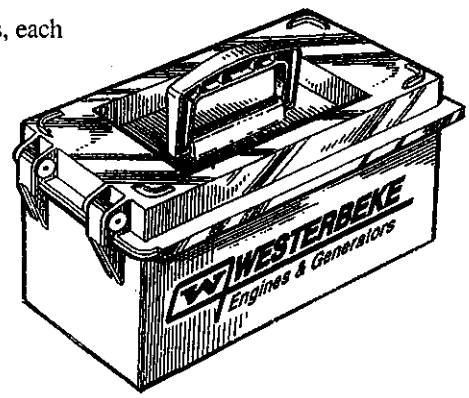
---

# SPARE PARTS KITS

WESTERBEKE also offers two Spare Parts Kits, each packaged in a rugged hinged toolbox.
Kit **A** includes the basic spares.
Kit **B** is for more extensive off-shore cruising.

### Kit A

Impeller Kit
Heat Exchanger Gasket
Oil Filter
Drive Belt
Zinc Anodes
Spark Plugs




### Kit B

Impeller Kit
Water Pump Repair Kit
Thermostat Kit
Zinc Anodes
Complete Gasket Kit
Heat Exchanger Gaskett
Oil Filter
Drive Belt
Spark Plugs

*WESTERBEKE CORPORATION • MYLES STANDISH INDUSTRIAL PARK*
*150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319 U.S.A.*
*TEL: (508) 823-7677 • FAX: (508) 884-9688 • Website: www.westerbeke.com*